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# The genera *Leucoagaricus* and *Leucocoprinus* (*Agaricales*, *Basidiomycota*) in Kerala State, India

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**Abstract** — Nine *Leucoagaricus* and fifteen *Leucocoprinus* species are recorded from Kerala State, India, including six new *Leucoagaricus* species (*Leucoagaricus crystalliferoides*, *L. subflavus, L. rufosquamulosus*, *L. candicans*, *L. luteosquamulosus*, *L. majusculus*) and four new *Leucocoprinus* species (*Leucocoprinus acutoumbonatus*, *L. delicatulus*, *L. munnarensis*, *L. pusillus*). A neotype from Kerala is designated for *Lepiota viridiflava,* rediscovered after nine decades and for which the new combination, *Leucoagaricus viridiflavus,* is proposed. A key to the *Leucoagaricus* and *Leucocoprinus* species collected during this study from Kerala is given and some taxonomic observations on the group are provided.

**Key words** — *Agaricaceae*, floristics, lepiotaceous fungi, taxonomy

## Introduction

Traditionally, pale-spored species of the family *Agaricaceae* possessing spores that are metachromatic in cresyl blue and mostly lacking clamp connections have been referred to either *Leucoagaricus* Locq. ex Singer or *Leucocoprinus* Pat. Of these, species with more or less fragile, coprinoid basidiomata with plicate-striate pileal margin and well developed pseudoparaphyses in the hymenium are placed in *Leucocoprinus* while those producing sturdier basidiomata with non-striate pilei and lacking pseudoparaphyses are referred to *Leucoagaricus*. *Macrolepiota* Singer, another pale-spored genus that with *Leucoagaricus* and *Leucocoprinus* is characterized by metachromatic spores, differs in producing generally larger and more robust basidiomata with plentiful clamp connections. *Macrolepiota* species are also characterized by a complex mobile annulus and a well-developed collarium (Franco-Molano 1999). Heinemann (1969) distinguished *Macrolepiota* from *Leucoagaricus* based on the simpler spore-wall structure and reduced germ-pore development in *Leucoagaricus*.

Although *Leucoagaricus* and *Leucocoprinus* are widely accepted as two morphologically distinct genera, several species could belong to either genus. For example, several species belonging to the 'rubentes group' of Babos (1979) or the 'badhamii complex' of Reid (1990) have been transferred back and forth (compare Babos 1979, Moser 1983, Reid 1990, and Wasser 1993 with Candusso & Lanzoni 1990, Bon 1996, and Vellinga 2001b) between the rather nebulous generic boundaries of *Leucoagaricus* and *Leucocoprinus* (Vellinga 2004b, Kumar & Manimohan 2004, Vellinga & Davis 2006). Although the presence of pseudoparaphyses in the hymenium of *Leucocoprinus* species has been found to be a useful distinguishing character in such cases (Singer 1986, Kumar & Manimohan 2004), a recent molecular study (Vellinga 2004b) questions the validity of this character. Compared to *Leucocoprinus, Leucoagaricus* is an even more heterogeneous group intermediate between *Leucocoprinus* and *Macrolepiota*, incorporating several borderline species. It accommodates species with very small, fragile basidiomata, like those found in many *Leucocoprinus* species, as well as those resembling large, robust *Macrolepiota* species.

The enigmatic status of many species placed in both *Leucoagaricus* and *Leucocoprinus* continues despite preliminary DNA-based analyses meant to refine generic circumscriptions. Molecular phylogenetic studies (Vellinga 2004b), though only weakly supported, indicate that *Leucoagaricus* and *Leucocoprinus* together form a large monophyletic lineage. This lineage includes the polyphyletic genus *Sericeomyces* Heinem., composed of species with whitish colours and a cuticular pileal covering, which many authors (Candusso & Lanzoni 1990, Vellinga 2000) consider as only a subgenus of *Leucoagaricus*. Data from the aforesaid molecular study (Vellinga 2004b) indicate the feasibility of treating the resolved monophyletic *Leucoagaricus/Leucocoprinus* clade either as one large genus, or splitting it into distinct, monophyletic genera (Vellinga & Davis 2006). It seems that before a clear concept of the complex could be arrived at, more molecular data should be generated and analyzed with better representation of tropical species.

The genera *Leucoagaricus* and *Leucocoprinus* are thought to be highly diverse and common in the tropics (Vellinga 2004a). However, their documentation from the tropics has been inadequate. Results of a floristic study of these genera, carried out in Kerala State, India, are presented here. This study documents nine species of *Leucoagaricus* and fifteen species of *Leucocoprinus* from this region. Traditional taxonomic concepts of *Leucoagaricus* and *Leucocoprinus* have been followed in this morphology-based study and the new species described are treated accordingly.

One species of *Leucoagaricus* (*L. quilonensis* Sathe & J.T. Daniel) and eleven species of *Leucocoprinus* (*L. biornatus* (Berk. & Broome) Locq., *L. birnbaumii*, *L. brebissonii*, *L. bresadolae* (Schulzer) M.M. Moser, *L. cepistipes* (Sowerby) Pat.,

*L. fragilissimus*, *L. meleagris* (Sowerby) Locq., *L. squamulosus* (Mont.) Pegler, *L. venezuelanus*, *L. zeylanicus* (Berk.) Boedjin, *L. lacrymans*) have already been recorded from Kerala (Sathe & Daniel 1980, Vrinda et al. 1997, 2003; Kumar & Manimohan 2004).

## Materials and methods

Conventional morphology-based taxonomic methods were employed for this study. Microscopic observations were made on material stained with 1% aqueous solutions of phloxine and Congo red and mounted in 3% aqueous KOH. Melzer's reagent, cresyl blue, and cotton blue were used to observe whether the spores were dextrinoid, metachromatic, and cyanophilic respectively. An average of 20 basidiospores per specimen was measured from spore prints or (when lacking) mature lamellae; standard deviation, Q (length/width) range, and Qm (average Q-value) were statistically derived for each species from a random selection of all spores measured. Colour codes refer to Kornerup & Wanscher (1978). Holotypes of all new taxa and additional and/or representative collections of all taxa documented here are deposited at Kew Herbarium and designated by their Kew (Mycology) accession numbers (e.g., K[M]158615). Unless otherwise indicated, all other examined collections cited are in the personal herbarium of the second author.

## Taxonomic account

### Key to the species of *Leucoagaricus* and *Leucocoprinus* of Kerala collected during this study

1a. Basidiomata more or less sturdy; pileus usually non-striate; pseudoparaphyses absent. . . . . .2 (*Leucoagaricus* species)

1b. Basidiomata mostly fragile; pileus radially striate; pseudoparaphyses well developed and abundant in the hymenium . . . . . 10 (*Leucocoprinus* species)

2a. Spores with a distinct germ-pore . . . . . .4

2b. Spores lacking a germ-pore or with a rudimentary one . . . . . .3

3a. Pileus usually red, brown, ochre, olive or orange pigmented; pileal covering a cutis of repent hyphae . . . . . .6

3b. Pileus differently and lightly pigmented; pileal covering a disrupted cutis with ascending or erect terminal elements . . . . . .9

4a. Basidiomata large; lamella-edge spotted dark brown; spores more than 10 µm long (10–15 × 7–9 µm); cheilocystidia and terminal elements of pileal covering with apical prolongation . . . . . ***L. majusculus***

4b. Basidiomata small to medium-sized; lamella-edge concolorous with the sides; spores less than 10 µm long; cheilocystidia and terminal elements of pileal covering without apical prolongation . . . . . .5

5a. Basidiomata medium-sized; pileus whitish to light orange with brownish red squamules; annulus fixed and with a coloured rim; pileal elements without encrusting pigments; spores 6.5–9 × 4–5 µm ..... ***L. rufosquamulosus***

5b. Basidiomata small; pileus whitish with brown to dark brown squamules; annulus movable and without a coloured rim; pileal elements with encrusting pigments; spores 5–10 × 3.5–5.5 µm ..... ***L. crystalliferoides***

6a. Pileus orange, brownish orange, brown or reddish brown ..... 7

6b. Pileus pastel yellow or white ..... 8

7a. Basidiomata small and somewhat delicate; pileal covering with two distinct layers; spores 6–8 × 3.5–4.5 µm ..... ***L. glabridiscus***

7b. Basidiomata small to medium-sized and rather robust; pileal covering single layered; spores 5–8 × 3.5–5 µm ..... ***L. rubrotinctus***

8a. Basidiomata pastel yellow, turning olive to dark grey on bruising; cheilocystidia ventricose, utriform or broadly clavate with apical prolongation; spores 5.5–8.5 × 4–5 µm ... ..... ***L. viridiflavus***

8b. Basidiomata white, not turning olive to dark grey on bruising; cheilocystidia narrowly clavate to clavate, cylindrical, ellipsoid, obovoid or rarely utriform without apical prolongation; spores 5–6.5 × 3.5–4 µm ..... ***L. candicans***

9a. Pileus and context yellow; spores 4–7 × 2.5–3.5 µm, amygdaliform .... ***L. subflavus***

9b. Pileus and context white; spores 6–11 × 5–7.5 µm, ellipsoid, broadly ellipsoid, ovoid or globose ..... ***L. luteosquamulosus***

10a. Spores with a conspicuous germ-pore ..... 11

10b. Spores without a germ-pore or with a rudimentary one ..... 22

11a. Basidiomata turning greenish on reaction with ammonia ..... 12

11b. Basidiomata not turning greenish on reaction with ammonia ..... 13

12a. Annulus persistent and with dense reddish brown squamules at the rim; cheilocystidia lageniform, utriform or broadly clavate with apical prolongation; pileal covering made of lageniform terminal elements with apical prolongation; spores 7–13 × 5–8 µm ..... ***L. holospilotus***

12b. Annulus evanescent, without any coloured squamules at the rim; cheilocystidia narrowly cylindric to flexuose without apical prolongation; pileal covering made of narrowly cylindrical to somewhat flexuose terminal elements; spores 5–13 × 4.5–11 µm ..... ***L. lacrymans***

13a. Pileal covering with inflated, globose or subglobose elements ..... 14

13b. Pileal covering without inflated globose or subglobose elements ..... 18

14a. Basidiomata extremely fragile, pastel yellow; spores 9.5–15 × 7–11 µm, often with an apical constriction ..... ***L. fragilissimus***

14b. Basidiomata more or less sturdy, whitish, dull white, orange grey, or yellowish white; spores smaller and without apical constriction ..... 15

15a. Lamellae initially white, turning yellowish white, yellowish brown or orange grey; stipe changing colour on bruising . . . . . .16

15b. Lamellae white to yellowish white; stipe not changing colour on bruising . . . . . .17

16a. Basidiomata somewhat fragile; annulus inferior to almost central, with concolorous squamules; cheilocystidia inflated clavate to ovoid; spores 8–11 × 5.5–7 µm … . . . . . ***L. ianthinus***

16b. Basidiomata sturdy; annulus superior, with dark brown squamules on the upper side; cheilocystidia lageniform or utriform with apical appendages; spores 8–11 × 6–8 µm . . . . . .***L. acutoumbonatus***

17a. Pileus yellowish white with brown squamules; spores 9–13 × 6–9 µm . . . . . ***L. brebissonii***

17b. Pileus white to pinkish white with cinnamon, rust brown or reddish brown squamules; spores 6–10 × 4.5–6.5 µm . . . . . .***L. venezuelanus***

18a. Pileus whitish with dark brown, grey or dark grey squamules . . . . . .19

18b. Pileus white or yellow with almost concolorous squamules . . . . . .21

19a. Basidiomata somewhat fragile; stipe slender (1–2 mm wide); context colour remaining unchanged; spores 9–12 × 6–7 µm . . . . . .***L. delicatulus***

19b. Basidiomata not fragile; stipe rather robust (more than 2 mm wide); context whitish turning brown on exposure . . . . . .20

20a. Pileus less than 20 mm in diameter; spores 7–10 × 5–6 µm, ovoid, ovo-ellipsoid, ellipsoid; pileal elements clavate, lageniform, cylindrico-clavate, utriform . . . . . ***L. pusillus***

20b. Pileus more than 20 mm in diameter; spores 8.5–12.5 × 6–8 µm, amygdaliform; pileal elements fusoid or cylindrical . . . . . ***L. munnarensis***

21a. Basidiomata white; stipe densely fibrillose to granular or wooly-floccose; spores 6–12 × 5–7 µm . . . . . ***L. cretaceus***

21b. Basidiomata yellow; stipe not densely fibrillose or wooly floccose; spores 8–11.5 × 5–7 µm . . . . . ***L. birnbaumii***

22a. Pileus non-striate; stipe turning rust brown to reddish brown on bruising; spores 5–9 × 3–4.5 µm, amygdaliform; cheilocystidia with apical prolongations; pileal covering with cylindrico-clavate elements . . . . . .***L. jubilaei***

22b. Pileus sulcate-striate; stipe colour unchanging; spores not amygdaliform; cheilocystidia without apical prolongations; pileal covering with ovoid, ellipsoid or globose elements . . . . . .23

23a. Pileus with yellowish squamules; spores 5–10.5 × 3.5–6 µm; pileal covering with chains of ovoid, ellipsoid or globose cells terminated by short cylindrical elements . . . . . ***L. submontagnei***

23b. Pileus with dark brown squamules; spores 5–6.5 × 3.5–4.5 µm; pileal covering composed entirely of globose elements . . . . . .***L. straminellus***

**Descriptions and comments on the species**

***Leucoagaricus majusculus*** T.K.A. Kumar & Manim., **sp. nov.** Figure 1

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*Pileus 80–85 mm latus, primo convexus, postea applanato expansus, albidus, squamulis brunneis obtectus. Lamellae liberae, albidae, confertae. Stipes 113–125 × 9–13 mm, albidus, vulnerato pallide brunneus, squamulis brunneis obtectus fibrillosus. Sporae 10–15 × 7–9 µm, ovoideae, ovo-ellipsoideae vel amygdaliformiae. Basidia 29–37 × 11–13 µm, clavata, 4-sporigera. Acies lamellarum sterilis. Cheilocystidia 17–75 × 6–30 µm, versiforma, tenuitunicata. Pleurocystidia nulla. Trama hymenophoralis subregularis, hyalina. Epicutis pilei disrupta, ex hyphis repentibus et hyphis erectis composita. Hyphae fibulatae.*

**Holotype — INDIA, Kerala State, Calicut District,** Arayedathupalam: 19 August 2005, Arun Kumar AK384 (K[M]158586).

Etymology: *majusculus* (Latin), somewhat large

Basidiomata large. Pileus 80–85 mm diam., convex when young, becoming applanate and finally concave with an upturned margin, with a low umbo; surface whitish with brown (7E8) to dark brown (7F8) fibrillose squamules radiating from the disc in broken concentric circles; disc pruinose to granular, finely striate towards the margin; margin initially incurved, becoming straight, eroded. Lamellae free, whitish, crowded, up to 7 mm wide, with lamellulae in 4–5 tiers; edge finely fimbriate to denticulate, with dark brown spots. Stipe 113–125 × 9–13 mm, central, terete, almost equal or expanding towards the base, fistulose; surface whitish with brown (7E8) squamules, turning light brown (5D5) on bruising and dark brown on drying, densely fibrillose to villose; base arising from a white mycelium. Annulus not observed. Context up to 3.5 mm thick, white. Odour not distinctive. Spore-print white.

Spores 10–15 × 7–9 (11.7 ± 1.4 × 7.7 ± 0.77) µm, Q = 1.3–1.9, Qm = 1.5, ovoid, ellipsoid to broadly ellipsoid or rarely amygdaliform, hyaline, with a germ-pore up to 1 µm broad or often inconspicuous, with refractive guttules, thick-walled (up to 1.5 µm), smooth, dextrinoid, distinctly metachromatic in cresyl blue, cyanophilous in cotton blue. Basidia 29–37 × 11–13 µm, clavate, with guttulate contents, hyaline, bearing 4 sterigmata up to 7.5 µm long. Lamella-edge sterile. Cheilocystidia abundant, 17–75 × 6–30 µm, clavate, obovoid, utriform, or lageniform, mostly with apical prolongations up to 35 µm long, thin-walled, pale yellowish brown to dark grey. Pleurocystidia none. Lamellar trama subregular; hyphae 2–8 µm, inflated up to 29 µm wide, loosely attached, hyaline to pale grey, thin-walled, inamyloid. Subhymenium cellular. Pileal trama interwoven; hyphae 2–23 µm wide, cylindrical, septate, hyaline, thin- to slightly thick-walled, inamyloid. Pileal covering mostly a cutis disrupted at the scales and towards the centre by trichodermial patches, entirely trichodermial at the disc; terminal elements 36–117 × 4–27 µm, clavate, utriform, or lageniform and mostly with one or more constrictions and having

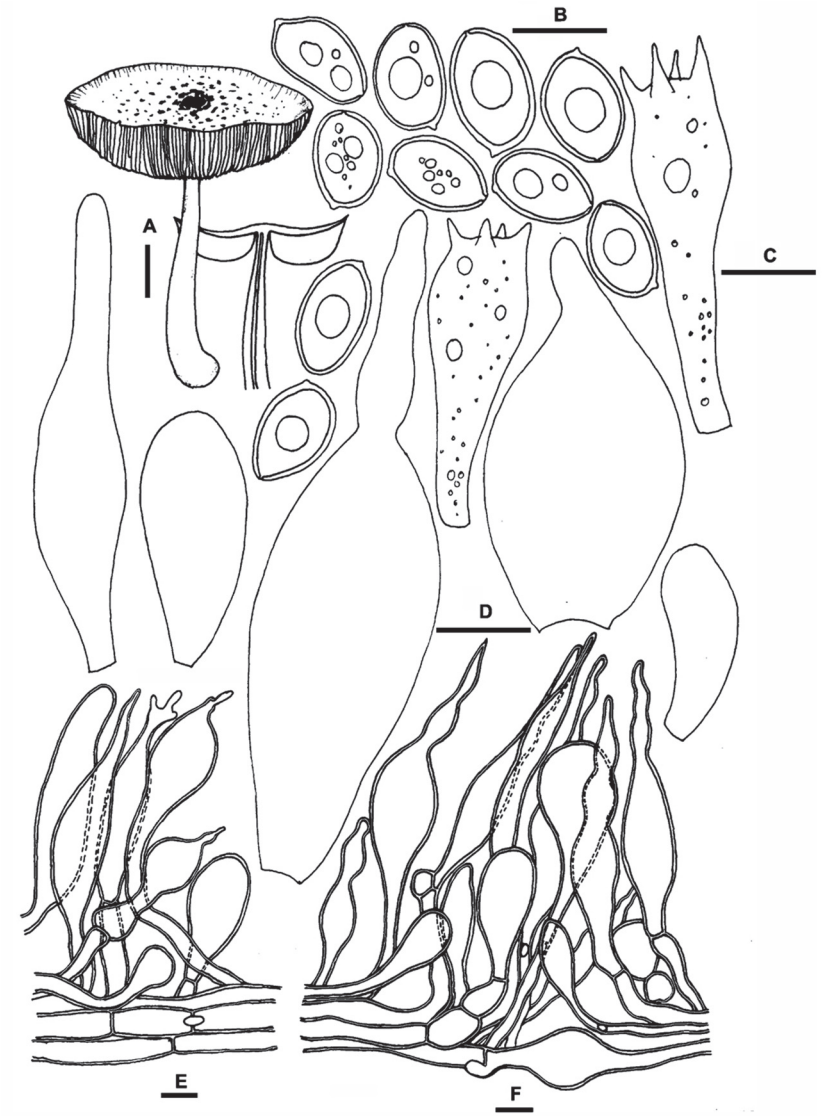


Figure 1. *Leucoagaricus majusculus*:
A, habit, scale bar = 10 mm; B, basidiospores; C, basidia;
D, cheilocystidia; E, stipe covering; F, pileus covering.
Scale bars (B–F) = 10 μm.

apical prolongations which are usually flexuose or moniliform, thick-walled (up to 1 µm), with brown to dark brown membrane- and plasmatic pigments. Stipe covering a cutis of 5–40 µm wide, hyaline to pale brown, slightly thick- to thick-walled (up to 2µm) hyphae; terminal elements 26–108 × 10–28 µm, cystidioid, clavate, utriform, lageniform, ovoid, most with apical prolongation, thick-walled, with brown to dark brown plasmatic and membrane pigments. Clamp connections present on hyphae of pileus and stipe covering and very rarely at the base of cheilocystidia.

Habitat: On decomposing saw dust, solitary.

Comments: *Leucoagaricus majusculus* is distinguished by large and fleshy basidiomata, spores that are longer than 10 µm, and a trichodermial pileal covering with clavate, utriform, or lageniform terminal elements mostly having flexuose or moniliform apical prolongations. Owing to this unique combination of characters, this species does not exactly fit in descriptions of any of the known species. The overall nature of the basidiomata, large spores, cheilocystidia and terminal elements of veil with apical prolongations all indicate a relation with species of the 'badhamii complex' (Reid 1990) that have been placed in either *Leucocoprinus* or *Leucoagaricus,* although a colour reaction with ammonia, characteristic of the complex, was not observed. [Some complex species show varied ammonia reactivity (from strong to feeble or none, as with *Leucocoprinus jubilaei*); see Reid 1990.] Further, the relatively fleshy basidiomata, absence of distinct plicate pileus striations, and absence of hymenial pseudoparaphyses rule out a position inside *Leucocoprinus* and are suggestive of *Leucoagaricus*.

The large basidiome and spore sizes indicate affinities with the genus *Macrolepiota.* The clamp connections observed in *L. majusculus* also suggest similarities with *Macrolepiota*. Nonetheless, although clamp connections are not considered diagnostic of *Leucoagaricus*, they are observed infrequently in many *Leucoagaricus* species. For example, Didukh et al. (2003) records the presence of clamp connections in *Leucoagaricus wichanskyi* (Pilát) Bon & Boiffard, *L. carneifolius* (Gillet) Wasser, and *L. leucothites* (Vittad.) Wasser. Several other *Leucoagaricus* species from Kerala (recorded in this study) also possessed infrequent clamp connections. Despite the clamp connections observed in *L. majusculus*, other diagnostic *Macrolepiota* characters such as a collarium and complex-walled spores possessing a well developed germ-pore were found lacking. These observations favour placement of this species in *Leucoagaricus*.

*Leucoagaricus majusculus* exhibits close similarities with *Leucocoprinus holospilotus* and *L. meleagris* although the former evidently lacks well-developed pseudoparaphyses. *Leucocoprinus holospilotus* possesses a persistent annulus and smaller spores while *L. meleagris* differs mainly in having smaller

basidiomata and context that becomes bright red on bruising. *Leucoagaricus dextrinoidesporus* (Z. S. Bi) Zhu L. Yang seems to be another closely related species. However, compared to *Leucoagaricus dextrinoidesporus*, *L. majusculus* has larger basidiomata that lack a distinct umbo, lamellae that do not turn purple red when mature, a whitish stipe surface, larger basidiospores that are hyaline and not pale greenish yellow in KOH mounts, and clamp connections.

***Leucoagaricus rufosquamulosus*** T.K.A. Kumar & Manim., **sp. nov.** Figure 2
MycoBank MB512336

*Pileus 45 mm latus, primo convexus, applanato expansus, umbonatus, albidus vel pallide luteus, squamulis rufo-brunneis, ad discum confertioribus obtectus, ad marginem striatus. Lamellae liberae, albidae, confertae. Stipes 42 × 3.5 mm, albidus vel pallide luteus, vulnerato griseo aurantiacus, fibrillosus. Sporae 6.5–9 × 4–5 µm, oblongo-ellipsoideae, subcylindriceae vel amygdaliformiae. Basidia 10–17 × 7–8 µm, clavata, 4-sporigera. Acies lamellarum sterilis. Cheilocystidia 16–40 × 7–15 µm, cylindricea, cylindrico-clavata vel utriformia, hyalina. Pleurocystidia nulla. Trama hymenophoralis subregularis, hyalina. Epicutis pilei disrupta, ex hyphis repentibus et hyphis erectis composita. Hyphae omnes defibulatae.*

**Holotype — INDIA, Kerala State, Wayanad District,** Muthanga: 2 June 2005, Arun Kumar AK222 (K[M]158615).

Etymology: *rufosquamulosus* (Latin), with red scales

Basidiomata medium-sized. Pileus 45 mm diam., initially convex, becoming broadly convex and finally applanate, with a broad umbo at the disc; surface whitish to light orange (6A4), with minute, brownish red (8C8), scattered, appressed-fibrillose squamules that are sparser towards the margin, pruinose to more or less smooth at the disc, finely striate at the margin; margin initially incurved, becoming straight, eroded. Lamellae free, whitish, crowded, up to 9 mm wide, with lamellulae in 3–4 tiers; edge fimbriate under a lens, concolorous with the sides. Stipe 42 × 3.5 mm, central, terete, equal, slightly bulbous at the base, initially solid, becoming fistulose with age; surface whitish to pale yellow (4A3), turning greyish orange (5B4) on bruising or with age, fibrillose; base arising from a white mycelium. Annulus superior, membranous, simple, ascending, fixed, with a rim covered with brownish red (8C8) fibrils. Context up to 1.5 mm thick, white. Odour not distinctive. Spore-print not obtained.

Spores 6.5–9 × 4–5 (7.8 ± 0.63 × 4 ± 0.44) µm, Q = 1.5–2.25, Qm = 2, oblong-ellipsoid, subcylindrical, amygdaliform, or more or less fusiform with a slight suprahilar depression, often with a germ-pore 0.5 to 1 µm broad and covered with an indistinct hyaline cap, hyaline, with refractive guttules, thick-walled (up to 1 µm), smooth, dextrinoid, metachromatic in cresyl blue, cyanophilous in cotton blue. Basidia 10–17 × 7–8 µm, almost ovoid to short clavate, hyaline, bearing 4 short sterigmata up to 2 µm long. Lamella-edge sterile. Cheilocystidia crowded, 16–40 × 7–15 µm, cylindrical, cylindrico-clavate, clavate, broadly

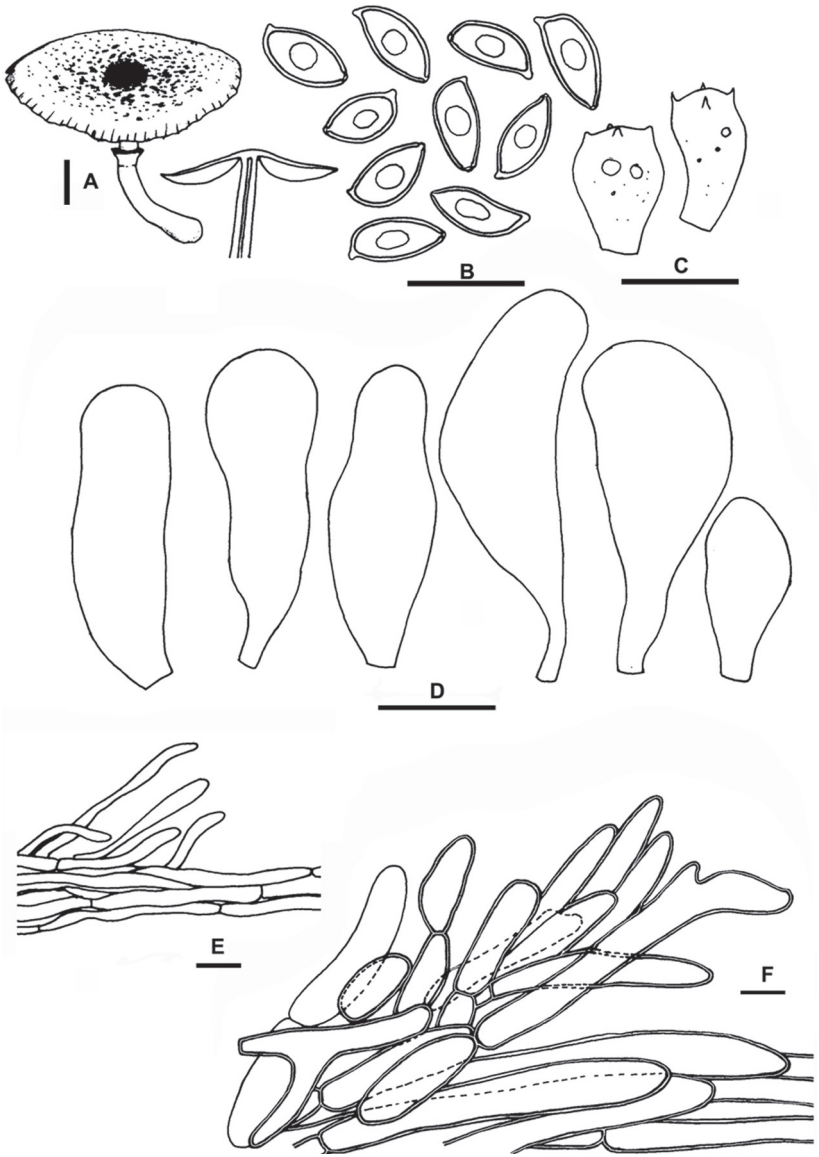


Figure 2. *Leucoagaricus rufosquamulosus*:
A, habit, scale bar = 10 mm; B, basidiospores; C, basidia;
D, cheilocystidia; E, stipe covering; F, pileus covering.
Scale bars (B–F) = 10 μm.

clavate, or utriform, thin-walled, hyaline. Pleurocystidia absent. Lamellar trama subregular; hyphae 5–13 µm wide, inflated, hyaline, thin-walled, inamyloid. Subhymenium cellular. Pileal trama interwoven; hyphae 2–25 µm wide, inflated, hyaline, thin-walled, inamyloid. Pileal covering a cutis of repent cylindrical hyphae disrupted by trichodermial patches of ascending or erect, loosely attached terminal elements; terminal elements 20–110 × 5–18 µm, cylindrical, cylindrico-clavate or ellipsoid, slightly thick- to thick-walled (up to 1 µm), with pale brown to brown plasmatic and membrane pigments. Stipe covering a cutis of repent hyphae with occasionally ascending hyphal filaments; hyphae 2–8 µm wide, thin-walled, hyaline. Clamp connections not observed.

Habitat: On soil, solitary.

Comments: *Leucoagaricus rufosquamulosus* is characterized by a pileus with brownish red squamules on a whitish to light orange background; oblong-ellipsoid, subcylindrical or amygdaliform spores with germ-pore covered by an indistinct hyaline cap; versiform cheilocystidia; and a pileal covering with loosely attached cylindrical, cylindrico-clavate or ellipsoid terminal elements. Since pseudoparaphyses were not observed in the hymenium, this species is referred to *Leucoagaricus*. Except for the persistent annulus, spores with germ-pore, short basidia, versiform cheilocystidia, and the lack of any encrusting pigments on the terminal elements on pileal covering, it is similar to *Leucoagaricus tener* (P.D. Orton) Bon.

***Leucoagaricus crystalliferoides*** T.K.A. Kumar & Manim., **sp. nov.** Figure 3

MycoBank MB512337

*Pileus 9–19 mm latus, primo convexus, postea applanatus, umbonatus, albidus, squamulis brunneis vel atrobrunneis obtectus. Lamellae liberae, primo albidae, postea brunneae, confertae. Stipes 25–38 × 1–2 mm, albidus, vulnerato brunneus. Sporae 5–10 × 3.5–5.5 µm, ellipsoideae, ovo-ellipsoideae, ovoideae, vel amygdaliformiae, poro germinativo instructae. Basidia 13–24 × 8–10 µm, clavata, 4-sporigera. Acies lamellarum sterilis. Cheilocystidia 10–75 × 7–12 µm, versiformia. Pleurocystidia nulla. Trama hymenophoralis subregularis, hyalina. Epicutis pilei disrupta, ex hyphis repentibus et hyphis erectis composita. Hyphae raro fibulatae.*

**Holotype — INDIA, Kerala State, Malappuram District,** Calicut University Campus: 26 June 2006, Arun Kumar AK398 (K[M]158614).

Etymology: *crystalliferoides* (Latin), similar to (*Leucoagaricus) crystallifer*

Basidiomata small. Pileus 9–19 mm diam., initially convex, becoming broadly convex to applanate, finally turning slightly depressed, with a low or sometimes prominent umbo; surface whitish to dull white, dotted with minute, brown (7E5, 7E6) to reddish brown (8E8) or dark brown (7F7, 8F8), appressed-fibrillose squamules, pruinose to more or less smooth towards the disc; margin

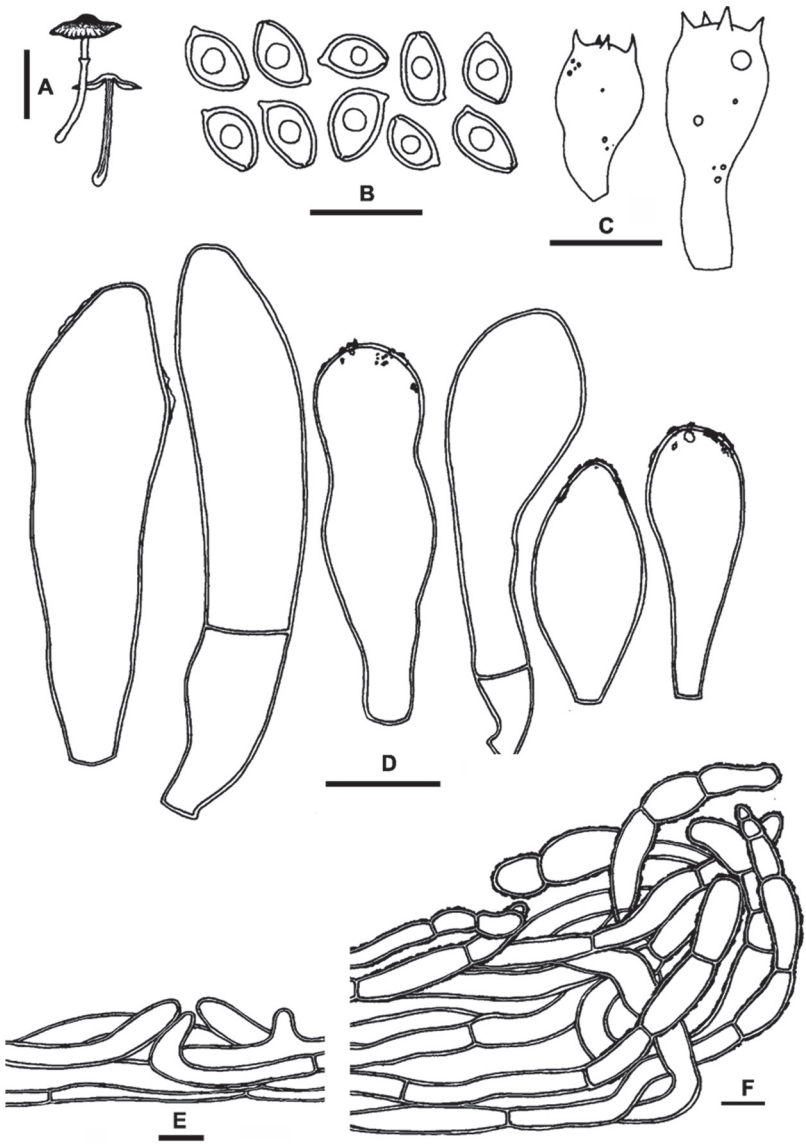


Figure 3. *Leucoagaricus crystalliferoides*:
A, habit, scale bar = 10 mm; B, basidiospores; C, basidia;
D, cheilocystidia; E, stipe covering; F, pileus covering.
Scale bars (B–F) = 10 μm.

initially incurved, later becoming straight, entire. Lamellae free, initially whitish, slowly turning yellowish white (2A2) to light brown (6D7) and finally brown (7E5) on bruising, drying or with age, moderately crowded to crowded, up to 2 mm wide, with lamellulae in 2–4 tiers; edge finely fimbriate under a lens, concolorous with the sides. Stipe 25–38 × 1–2 mm, central, terete, equal, slightly bulbous at the base, initially solid, becoming fistulose; surface whitish, turning light brown (6D7) to brown (7E5) on bruising or on drying, almost glabrous or slightly fibrillose; base arising from a white mycelium. Annulus almost central or superior, membranous, simple, ascending, movable, evanescent. Context up to 1 mm thick, whitish, changing to light brown (6D7), and gradually brown (7E5) on exposure. Odour not distinctive. Spore-print white.

Spores 5–10 × 3.5–5.5 (6.7 ± 0.89 × 4 ± 0.54) µm, Q = 1.3–1.8, Qm = 1.5, ellipsoid, ovo-ellipsoid, ovoid or amygdaliform, with an inconspicuous or distinct germ-pore up to 1 µm broad, hyaline, with refractive guttules, somewhat thick-walled (up to 1 µm), smooth, dextrinoid, metachromatic in cresyl blue, cyanophilous in cotton blue. Basidia 13–24 × 8–10 µm, clavate to broadly clavate, hyaline, bearing 4 sterigmata up to 5 µm long. Lamella-edge sterile. Cheilocystidia crowded, 10–75 × 7–12 µm, cylindric, cylindrico-clavate, clavate, broadly clavate, utriform, ventricose, fusoid, broadly fusoid, or rarely strangulated, mostly septate, thin- to thick-walled (up to 1 µm), with fine guttulate contents and often with fine granular exudates on the surface, hyaline. Pleurocystidia absent. Lamellar trama subregular; hyphae 2–25 µm wide, inflated, hyaline, thin- to slightly thick-walled, inamyloid. Subhymenium cellular. Pileal trama interwoven; hyphae 3–40 µm wide, inflated, hyaline, thin-walled, inamyloid. Pileal covering a repent cutis composed of 3–10 µm wide, slightly thick- to thick-walled (up to 1 µm) hyphae towards the margin, highly disrupted towards the centre and forming a trichodermium at the disc with ascending or erect terminal cells; terminal cells short, ellipsoid to cylindrical, 3–12 µm wide, thick-walled (up to 1 µm), with brown to dark brown plasmatic, membrane-, and encrusting pigments. Stipe covering a cutis of repent hyphae with occasional ascending hyphae; hyphae 3–10 µm wide, thin- to slightly thick-walled, with hyaline to pale brownish plasmatic pigment. Clamp connections rare, observed on hyphae of pileal covering.

Habitat: On soil, solitary.

Additional collections examined — **India, Kerala State, Malappuram District,** Calicut University Campus: 10 July 2006, Arun Kumar *AK415;* 26 September 2006, Arun Kumar *AK443* (*K(M)158618);* 27 September 2006, Arun Kumar *AK448.*

Comments: Distinctive characters of this rather small species are a whitish pileus with brown fibrillose squamules, lamellae and stipe that turn light

brown to brown on bruising, ellipsoid spores with a germ-pore, thick-walled cheilocystidia with fine granular exudates, and a cutis-type pileal covering that becomes trichodermial towards the disc with ascending or erect short ellipsoid to cylindrical terminal elements having plasmatic, membrane-, and encrusting pigments. Another remarkable observation is the rare occurrence of clamp connections, which are regarded as uncharacteristic of *Leucoagaricus*. However, spores of *Leucoagaricus crystalliferoides* do possess a noticeable germ-pore and exhibit a typical metachromatic reaction with cresyl blue, typical characters for the genus. *Leucoagaricus crystallifer* Vellinga, which appears to exhibit somewhat similar characters (Vellinga 2000, 2001b), differs in producing slightly larger basidiomata, apically papillate spores lacking a germ-pore, and pileal elements with different terminal cells. The ellipsoid spores with germ-pore in *L. crystalliferoides* differentiate it from other similar species such as *L. sericifer* (Locq.) Vellinga and *L. sublittoralis* (Kühner ex Hora) Singer.

***Leucoagaricus glabridiscus*** (Sundb.) Wuilb., Doc. Mycol. 17(65): 46 (1986)

Collections examined — **INDIA**, **Kerala State, Malappuram District,** Calicut University Campus: 13 April 2005, Arun Kumar *AK212*; 15 April 2005, Arun Kumar *AK212a*; 3 June 2005, Arun Kumar *AK212b* (*K(M)158609*); 8 June 2005, Arun Kumar *AK212c*; 27 June 2005, Arun Kumar *AK297* (*K(M)158612*).

Comments: Characters of these collections perfectly agree with the original description of the species from the Pacific coast of USA except for the density of the lamellulae (5–6 tiers in the Kerala collections versus only 1–2 tiers in the USA material), slightly shorter spores (up to 10.3 µm in USA collections versus only up to 8 µm in Kerala collections), and the very rarely observed clamp connections. *Leucoagaricus glabridiscus* differs from the closely related *L. rubrotinctus* in its rather frail stature, smaller size, and double layered pileal covering of interwoven hyphae.

***Leucoagaricus rubrotinctus*** (Peck) Singer, Sydowia 2: 36 (1948)

Collections examined — **INDIA**, **Kerala State, Calicut District,** Puthiyangadi: 10 April 2005, Arun Kumar *AK208*; **Malappuram District,** Calicut University Campus: 29 June 2005, Arun Kumar *AK323* (*K(M)158597*); 30 June 2005, Arun Kumar *AK323a*; 8 July 2005, Arun Kumar *AK345* (*K(M)158598*).

Comments: The present collections have characters that agree well with the published descriptions of *Leucoagaricus rubrotinctus*. This ubiquitous species is easily recognized in the field by its shades of pale orange to reddish orange or reddish brown colours of the pileal covering. Murrill (1912) differentiated this species from the closely similar *Lepiota rubrotinctoides* Murrill based on its'larger size, darker umbo, smaller spores, and the absence of scales on the surface of the pileus.'

***Leucoagaricus viridiflavus*** (Petch) T.K.A. Kumar & Manim., **comb. nov.**

MycoBank MB512345 Figure 4

Basionym: *Lepiota viridiflava* Petch, Annals of the Royal Botanic Garden, Peradeniya 6: 195 (1917).

**Neotype, here designated: INDIA, Kerala State,** Malappuram District, Calicut university campus: *K(M)158611* (Arun Kumar *AK80*), 23 July 2004.

Basidiomata small, all parts readily turning olive (1E4, 1E5) to dark olive (2F8) and finally dark grey (1F1) on bruising. Pileus 11–29 mm diam., conico-convex when young, becoming convex to applanate with age, somewhat broadly umbonate; surface pastel yellow (1A4, 1A5), glabrous or rarely with minute appressed concolorous or olive (1E4, 1E5) fibrils, non-striate; margin initially incurved, becoming straight, entire or sometimes with velar remnants, becoming fissile with age. Lamellae free, moderately crowded to crowded, up to 4 mm wide, pastel yellow (1A4, 1A5) to greenish yellow (1A7), with lamellulae in 2–4 tiers; edge finely fimbriate under a lens, greenish in older specimens. Stipe 40–70 × 2–4 mm, central, terete, almost equal and with a slightly bulbous base (up to 6mm wide), initially solid, becoming fistulose with age; surface pastel yellow (1A4, 1A5, 2A4), smooth, fibrillose towards base. Annulus superior, membranous, evanescent. Context up to 4 mm thick at the disc, pastel yellow (1A3), changing olive (1E5, 1E6) to dark olive (2F8) on exposure. Odour not distinctive. Spore-print not obtained.

Spores 5.5–8.5 × 4–5 (6.9 ± 0.79 × 4.4 ± 0.64) µm, Q = 1.4–1.8, Qm =1.64, ovo-ellipsoid to subamygdaliform with a truncated apex, with an inconspicuous germ-pore, with a pale green tinge or almost hyaline, with refractive guttules, thick-walled, smooth, dextrinoid, metachromatic in cresyl blue, cyanophilous in cotton blue. Basidia 19–26 × 7.5–9 µm, clavate, with green vacuolar pigments, bearing 4 sterigmata up to 5 µm long. Lamella-edge sterile. Cheilocystidia crowded, 15–38 × 7–18 µm, utriform, ventricose or broadly clavate, thin-walled, mostly with an apical prolongation up to 16 µm long and 6 µm wide, often with amorphous contents and covered with similar exudates towards the apex, hyaline. Pleurocystidia absent. Lamellar trama subregular; hyphae inflated, septate, 2–20 µm wide, hyaline, thin-walled, inamyloid; Subhymenium cellular. Pileal trama parallel-interwoven; hyphae closely septate, inflated, 5–20 µm wide, hyaline to pale yellowish green, thin-walled, inamyloid, with obtuse tips. Pileal covering an undifferentiated cutis of repent, cylindric, septate, 3–12 µm wide, thin-walled, yellow or yellowish green to green pigmented hyphae. Stipe covering a cutis; hyphae 3–10 µm wide, thin-walled, with greenish plasmatic pigment. Clamp connections very rarely observed in the hyphae of the pileal trama.

Habitat: On soil, among decaying *Acacia* leaves, solitary or scattered.

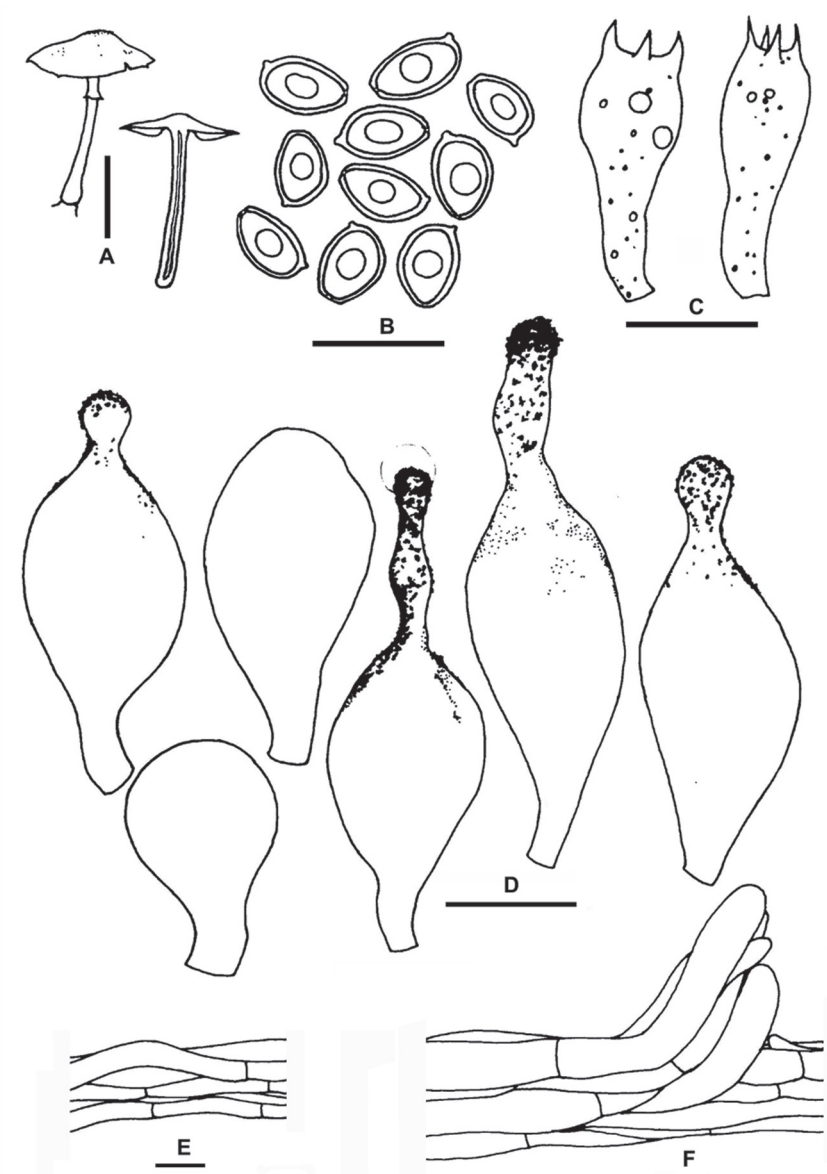


Figure 4. *Leucoagaricus viridiflavus*:
A, habit, scale bar = 10 mm; B, basidiospores; C, basidia;
D, cheilocystidia; E, stipe covering; F, pileus covering.
Scale bars (B–F) = 10 µm.

Other collections examined — **INDIA**, **Kerala State, Malappuram District,** Calicut university campus: 3 June 2004, Arun Kumar *AK45*; 4 June 2004, Arun Kumar *AK47*; 4 June 2004, Arun Kumar *AK45a*; 8 June 2004, Arun Kumar *AK45b*; 9 June 2004, Arun Kumar *AK52*; 7 October 2004, Arun Kumar *AK 128* (*K(M)158610*); 10 November 2004, Arun Kumar *AK185*; 10 November 2004, Arun Kumar *AK80a*.

Comments: *Leucoagaricus viridiflavus* fruits widely and regularly in the Calicut University campus and adjoining areas around *Acacia* trees during dry spells immediately after heavy rains. It has not been encountered so far from other parts of the State.

This species is remarkable for the olive green colouration that develops on all parts of the basidiomata upon bruising. It is further characterized by its yellowish colour, nearly smooth pileus, non-striate, occasionally velate pileal margin, subbulbous stipe base, and evanescent annulus. The metachromatic, ovo-ellipsoid to subamygdaliform spores with truncate apex and inconspicuous germ-pore and versiform cheilocystidia with long apical prolongations ornamented with amorphous encrustations are also characteristic of this species.

The present collections exhibit all character states cited by Petch (1917) in the original description of *Lepiota viridiflava* based on material from Sri Lanka. Petch, however, gave only a scanty description of this species and the only microscopic data provided were on the size and shape of the spores. Microscopical examinations of the present collections show spores that possess a difficult to distinguish, inconspicuous germ-pore and an inner wall layer that is metachromatically reactive in cresyl blue. The cheilocystidia have apical prolongations that are found in many *Leucoagaricus* and *Leucocoprinus* species. Except for the extremely rarely observed clamp connections, these specific characters favour a position inside the *Leucoagaricus*/*Leucocoprinus* complex, in contrast to its current placement in the genus *Lepiota*. Owing to the somewhat robust nature of the basidiomata, the lack of distinct striations on the pileus and the absence of pseudoparaphyses in the hymenium, this species is treated under *Leucoagaricus* in this study.

In his original description of this species, Petch (1917) did not cite any type material. Stating that no material for this species could be traced for examination, Pegler (1972, 1986) entirely reproduced Petch's original account of the species in his accounts of agarics of Sri Lanka, 'for the sake of completeness.' Recently, Akers et al. (2000) described a new species (*Leucoagaricus viridiflavoides* B.P. Akers & Angels) from Florida and discussed its affinities to related taxa including *Lepiota viridiflava,* noting the inability to locate any available representative collections of *L. viridiflava* in herbaria. A thorough literature search also indicates that the species has not been collected from either its type locality or anywhere else since its original discovery. As the holotype for

*L. viridiflava* appears to be lost, collection K(M)158611 from Kerala is proposed here as neotype for this species.

*Leucoagaricus viridiflavoides* and *L. sulphurellus* (Pegler) B.P. Akers are two closely related species characterized by yellow flesh that bruises bluish green. The Akers et al. (2000) study of the *L. sulphurellus* holotype showed it to be distinct from *L. viridiflavus*. *Leucoagaricus viridiflavoides* can be distinguished from *L. viridiflavus* based on spore size, presence of pleurocystidia, and shape of pileal covering elements.

***Leucoagaricus candicans*** T.K.A. Kumar & Manim., **sp. nov.** FIGURE 5

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*Pileus 15–43 mm latus, primo companulatus, postea convexus, umbonatus, squamulosus, albus, ad marginem striatus. Lamellae liberae, albidae, confertae. Stipes 25–86 × 2–5 mm, albidus, vulnerato pallide luteus. Sporae 5–6.5 × 3.5–4 µm, ellipsoideae, ovoideae vel amygdaliformiae. Basidia 11–15 × 6–8 µm, clavata, 4- sporigera. Acies lamellarum sterilis. Cheilocystidia 19–42 × 11.5–17 µm,versiformia. Pleurocystidia nulla. Trama hymenophoralis subregularis, hyalina. Epicutis pilei ex hyphis repentibus composita. Hyphae raro fibulatae.*

**HOLOTYPE — INDIA, KERALA STATE, Malappuram District,** CALICUT UNIVERSITY CAMPUS: 3 June 2005, Arun Kumar AK230 (K[M]158587).

ETYMOLOGY: *candicans* (Latin), white

BASIDIOMATA medium-sized. PILEUS 15–43 mm diam., initially campanulate with an umbo, becoming convex to broadly convex on maturity, distinctly umbonate at the disc; surface white, with concolorous or occasionally yellowish white (2A2), recurved, fibrillose squamules, striate towards margin; margin initially incurved, becoming straight, eroded. LAMELLAE free, whitish, crowded, up to 5 mm wide, with lamellulae in 2–3 tiers; edge finely fimbriate under a lens, concolorous with the sides. STIPE 25–86 × 2–5 mm, central, terete, almost equal but slightly expanded towards base (up to 6 mm), initially fistulose becoming hollow with age; surface whitish, turning pale yellow (4A3) on bruising, almost glabrous; base arising from a white mycelium. ANNULUS superior or central, membranous, simple, ascending, fixed. CONTEXT up to 1 mm thick, whitish, changing to pale yellow (4A3) on exposure. ODOUR not distinctive. SPORE-PRINT white.

SPORES 5–6.5 × 3.5–4 (5.7 ± 0.44 × 4 ± 0.2) µm, Q = 1.3–1.7, Qm = 1.5, ellipsoid to ovoid or amygdaliform, without a germ-pore, hyaline, with refractive guttules, thick-walled (up to 1 µm), smooth, dextrinoid, metachromatic in cresyl blue, cyanophilous in cotton blue. BASIDIA 11–15 × 6–8 µm, short clavate, hyaline, bearing 4 short sterigmata up to 2 µm long. LAMELLA-EDGE sterile. CHEILOCYSTIDIA crowded, 19–42 × 11.5–17 µm, narrowly clavate, clavate, cylindrical, ellipsoid, obovoid or rarely utriform, thin-walled, hyaline.

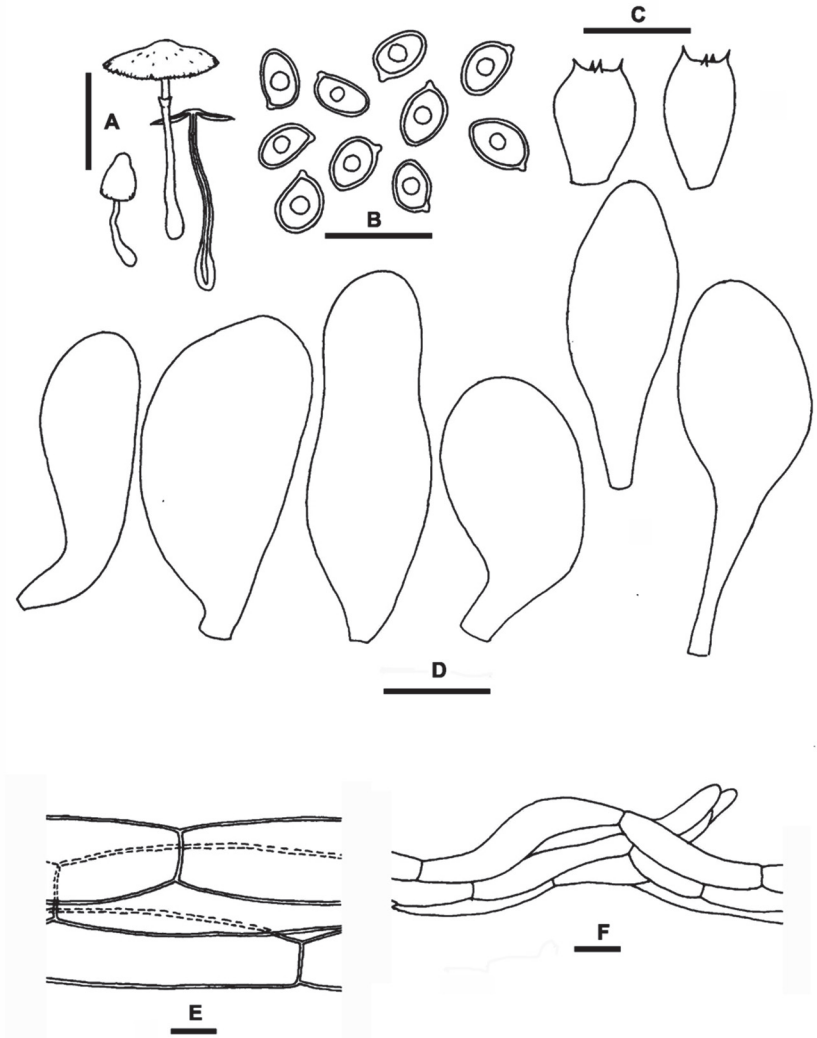


Figure 5. *Leucoagaricus candicans*:
A, habit, scale bar = 10 mm; B, basidiospores; C, basidia;
D, cheilocystidia; E, stipe covering; F, pileus covering.
Scale bars (B–F) = 10 μm.

Pleurocystidia absent. Lamellar trama subregular; hyphae 2–30 µm wide, inflated, branched, hyaline, thin-walled, inamyloid. Subhymenium cellular. Pileal trama interwoven, composed of highly inflated, 3–40 µm wide, hyaline, thin-walled, inamyloid hyphae. Pileal covering a repent cutis of inflated, 2–25 µm wide, thin-walled hyaline hyphae with occasionally ascending terminal elements. Stipe covering a cutis of slightly inflated, thin- to slightly thick-walled, 3–34 µm wide, hyaline hyphae. Clamp connections rarely present on hyphae of the pileal covering.

Habitat: On soil, among decaying leaf litter, solitary or scattered.

Additional collection examined — **INDIA, Kerala State, Malappuram District,** Calicut University Campus: 6 June 2005, Arun Kumar *AK235* (*K(M)158588*).

Comments: This thin-fleshed species is diagnosed by a pure white pileus covered with almost concolorous squamules, a fixed annulus, ellipsoid to amygdaliform spores without a germ-pore, short clavate basidia, and a cutis-type pileal covering. *Leucoagaricus candicans* is assigned to *Leucoagaricus* because of the absence of distinct plicate/sulcate striations on the pileus and lack of hymenial pseudoparaphyses. *Leucoagaricus hortensis* (Murrill) Pegler (≡ *Chlorophyllum hortense* (Murrill) Vellinga), another white species, differs on account of its larger fleshy basidiomata whose stipe context shows strong reddening reaction when bruised, two-spored basidia, larger spores, and a subhymeniform pileal covering with clavate terminal elements.

***Leucoagaricus subflavus*** T.K.A. Kumar & Manim., **sp. nov.** Figure 6

MycoBank MB512339

*Pileus 10–22 mm latus, primo ovoideus, postea convexus et applanato expansus, uatus, luteus, squamulis luteis obtectus. Lamellae liberae, primo albae, postea pallide luteae, confertae. Stipes 14–30 × 1–3 mm, albidus. Sporae 4–7 × 2.5–3.5 µm, amygdaliformiae. Basidia 11–23 × 5–8 µm, clavata, 4-sporigera. Acies lamellarum sterilis. Cheilocystidia 20–39 × 6.5–12 µm, cylindrico-clavata vel clavata.,Pleurocystidia nulla. Trama hymenophoralis subregularis, hyalina. Epicutis pilei disrupta, ex hyphis repentibus et hyphis erectis composita. Hyphae omnes defibulatae.*

Holotype — **INDIA, Kerala State, Malappuram District,** Calicut University Campus: 4 October 2004, Arun Kumar AK116 (K[M]158613).

Etymology: *subflavus* (Latin), pale yellowish

Basidiomata small. Pileus 10–22 mm diam., ovoid when young, becoming convex to broadly convex and finally applanate, with an indistinct umbo; surface yellow (2A6), yellowish white (2A2) towards margin, with concolorous recurved squamules scattered except at the disc which remains smooth, sulcate-striate towards margin; cuticle peeling off as a layer at maturity or on ageing revealing the underlying context; margin initially incurved, becoming straight or upturned with age, entire to slightly crenate. Lamellae free, initially white,

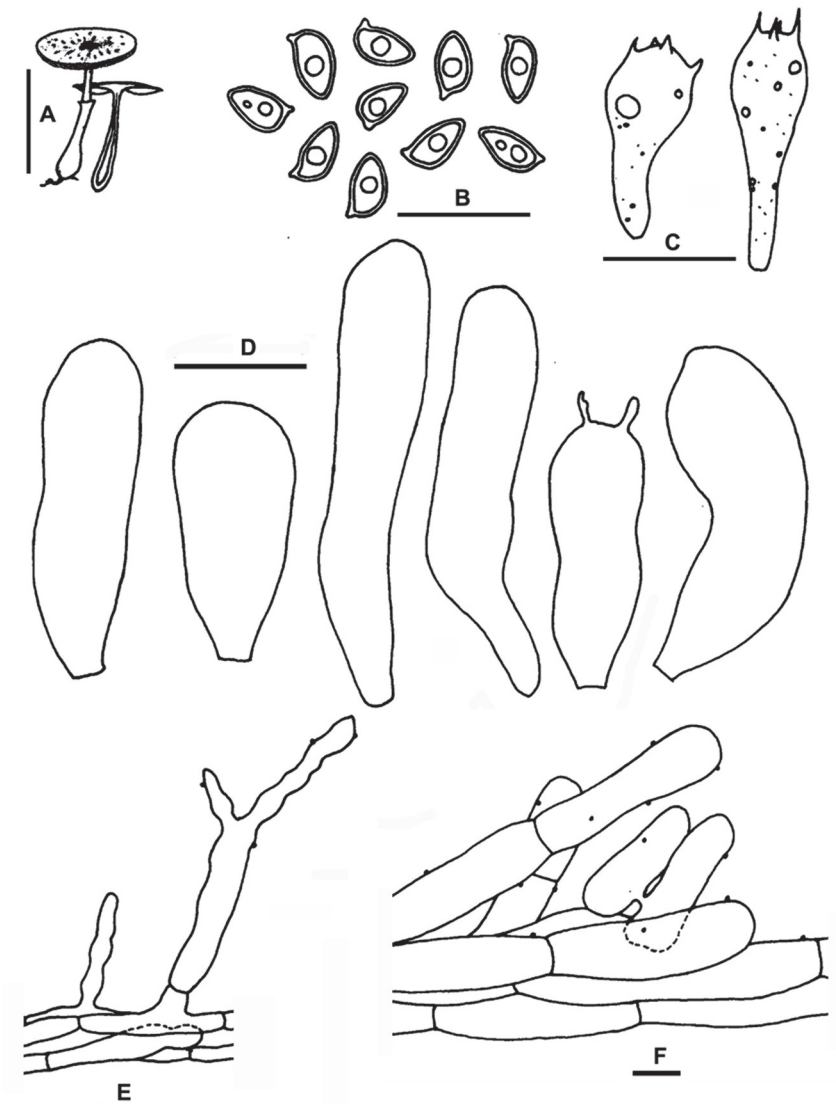


Figure 6. *Leucoagaricus subflavus*:
A, habit, scale bar = 10 mm; B, basidiospores; C, basidia;
D, cheilocystidia; E, stipe covering; F, pileus covering.
Scale bars (B–F) = 10 μm.

becoming yellowish white (2A2), close to crowded, up to 4 mm wide, with lamellulae in 2–3 tiers; edge finely fimbriate under a lens, concolorous with the sides. Stipe 14–30 × 1–3 mm (up to 6 mm wide at the base), central, terete, expanded towards the base, solid when young, becoming fistulose and finally hollow with age; surface whitish, fibrillose; base arising from a white mycelium. Annulus central, membranous, ascending, fixed. Context up to 1 mm thick, yellow (2A6). Odour not distinctive. Spore-print white.

Spores 4–7 × 2.5–3.5 (5.5 ± 0.8 × 3 ± 0.2) µm, Q = 1.6–2.3, Qm = 1.9, amygdaliform, hyaline, with refractive guttules, thick-walled, smooth, dextrinoid, weakly metachromatic in cresyl blue, cyanophilous in cotton blue. Basidia 11–23 × 5–8 µm, clavate, hyaline, with guttulate contents, bearing 4 sterigmata up to 3 µm long. Lamella-edge sterile. Cheilocystidia 20–39 × 6.5–12 µm, cylindrico-clavate to inflated clavate, rarely with 1–2 finger-like apical protrusions, hyaline, thin-walled. Pleurocystidia absent. Lamellar trama subregular; hyphae 2–18 µm wide, inflated, septate, hyaline, thin-walled, inamyloid. Subhymenium cellular. Pileal trama interwoven; hyphae 2–25 µm wide, inflated, hyaline, thin-walled, inamyloid. Pileal covering a cutis of loosely attached 3–25 µm wide, inflated hyphae, thin-walled, hyaline to pale yellow, occasionally disrupted by ascending, terminal elements; terminal elements 16–53 × 8–22 µm, cylindrical, thin-walled, with pale yellow plasmatic pigment. Stipe covering a cutis of 2–10 µm wide, hyaline, thin-walled hyphae with cylindrical or moniliform, at times branched elements often arising as lateral branches; terminal elements 21–90 × 4–9 µm, hyaline, thin-walled. All hyphae lack clamp connections.

Habitat: On soil and on decaying leaf litter, solitary.

Additional collections examined — **INDIA, Kerala State, Malappuram District,** Calicut university campus: 5 October 2004, Arun Kumar *AK123* (*K(M)158589*); 15 October 2004, Arun Kumar *AK138*; 26 October 2004, Arun Kumar *AK150*; 1 November 2004, Arun Kumar *AK116a*.

Comments: *Leucoagaricus subflavus* is characterized by a yellowish pileus with striations towards the margin, amygdaliform spores that are dextrinoid and weakly metachromatic in cresyl blue, cylindrico-clavate to inflated clavate cheilocystidia rarely having apical projections, a cutis-type pileal covering disrupted by ascending cylindrical terminal elements, a stipitipellis with branched, cylindrical or distinctly moniliform elements, and the absence of clamp connections. Although *L. subflavus* has weakly metachromatic spores, a combination of characters such as total absence of clamp connections and presence of cheilocystidia with apical extensions justify its placement in *Leucoagaricus* rather than in *Lepiota* sensu stricto. Placement in *Leucocoprinus* is also ruled out because of the lack of pseudoparaphyses in the hymenium. *Leucoagaricus serenus* (Fr.) Bon & Boiffard, a closely related species, differs in

being a predominantly white species with whitish context with larger spores and long pedicellate cheilocystidia. *Leucoagaricus sericifer* has basidiomata that turn brown on bruising, larger spores, and distinctly lageniform cheilocystidia with crystals at the apex.

***Leucoagaricus luteosquamulosus*** T.K.A. Kumar & Manim., **sp. nov.** FIGURE 7

MycoBank MB512340

*Pileus 10–15 mm latus, primo subglobosus, postea, applanato expansus, albus, squamulis minutis pallide luteis ad discum confertioribus obtectus, ad marginem striatus. Lamellae liberae, albae, confertae. Stipes 15–34 × 1–2 mm, albus, fibrilloso-villosus. Sporae 6–11 × 5–7.5 µm, ellipsoideae, ovoideae vel subglobosae. Basidia 19–40 × 10–15 µm, clavata, 4-sporigera. Acies lamellarum sterilis. Cheilocystidia 17–57 × 6–26 µm, versiformia, hyalina. Pleurocystidia nulla. Trama hymenophoralis subregularis, hyalina. Epicutis pilei disrupta, ex hyphis repentibus et hyphis erectis composita. Hyphae omnes defibulatae.*

**Holotype — INDIA, Kerala State, Calicut District,** Puthiyangadi: 30 September 2004, Arun Kumar AK 111 (K[M]158585).

Etymology: *luteosquamulosus* (Latin), with yellow scales

Basidiomata small. Pileus 10–15 mm diam., subglobose when young, becoming convex to broadly convex and finally applanate, with an indistinct umbo; surface white, with minute, recurved, pale yellow (3A3) to orange white (5A2) or brownish orange (5C4) squamules scattered throughout and concentrated towards the disc, canescent, distinctly sulcate-striate towards margin; margin initially incurved, later straight, crenate. Lamellae free, white, close to moderately crowded, up to 2 mm wide, with lamellulae in 2–3 tiers; edge finely fimbriate under a lens, concolorous with the sides. Stipe 15–34 × 1–2 mm (up to 5 mm wide at the base), central, terete, almost equal above the annulus, expanding towards base, initially solid, becoming fistulose; surface white, fibrillose-villose; base arising from white mycelial cords. Annulus central or superior, membranous, descending, fixed. Context less than 1 mm thick, white. Odour not distinctive. Spore-print white.

Spores 6–11 × 5–7.5 (8.5 ± 1 × 6 ± 0.09) µm, Q = 1.1–1.8, Qm = 1.5, ellipsoid, broadly ellipsoid, ovoid, or subglobose, without a germ-pore, hyaline, with refractive guttules, somewhat thick-walled, smooth, dextrinoid, metachromatic in cresyl blue, cyanophilous in cotton blue. Basidia 19–40 × 10–15 µm, clavate to broadly clavate, with guttulate contents, bearing 4 sterigmata up to 5 µm long. Lamella-edge sterile with crowded cheilocystidia. Cheilocystidia 17–57 × 6–26 µm, versiform: obovoid, oblong, ellipsoid, inflated-clavate, utriform or rarely cylindrical, hyaline, thin-walled. Pleurocystidia absent. Lamellar trama subregular; hyphae 2–30 µm wide, inflated, septate, hyaline, thin-walled, inamyloid. Subhymenium cellular. Pileal trama interwoven; hyphae 3–23 µm wide, inflated, hyaline, thin-walled, inamyloid. Pileal covering a cutis of 5–12 µm wide, filamentous hyphae disrupted by ascending or erect patches of

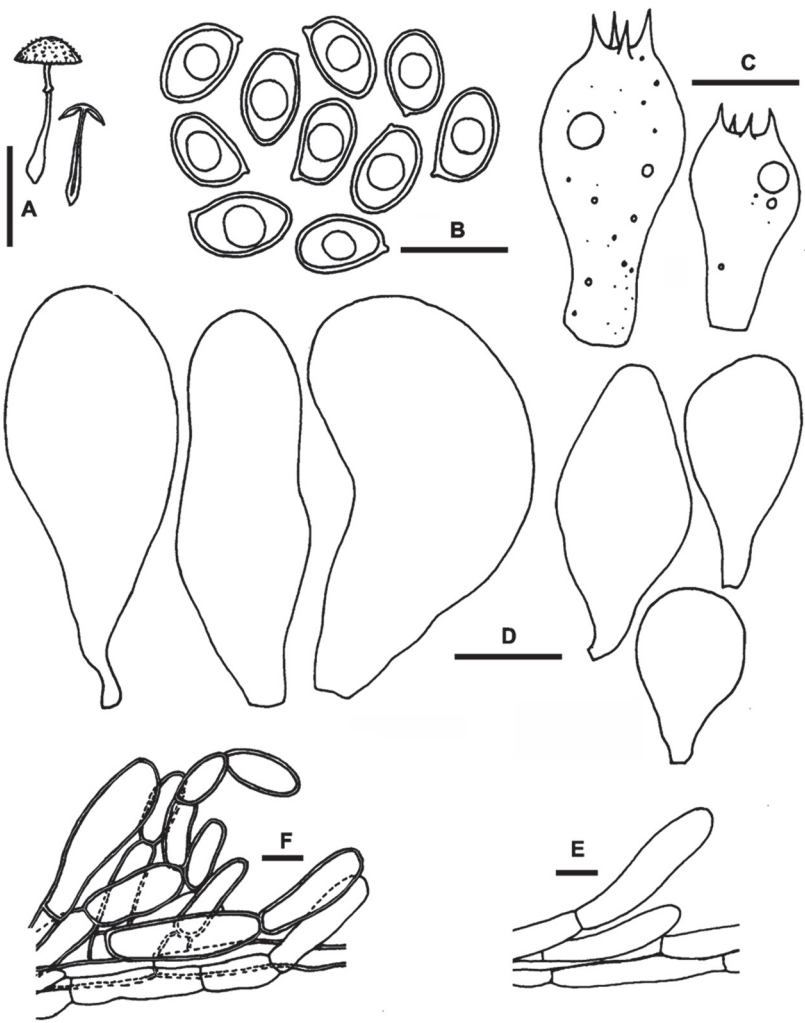


Figure 7. *Leucoagaricus luteosquamulosus*:
A, habit, scale bar = 10 mm; B, basidiospores; C, basidia;
D, cheilocystidia; E, stipe covering; F, pileus covering.
Scale bars (B–F) = 10 μm.

hyphae with cylindrical or clavate terminal elements; terminal elements, 22–70 × 6–20 µm, hyaline to pale yellow, thin-walled. Stipe covering a disrupted cutis of 2–20 µm wide, hyaline to pale yellow, thin-walled, branched hyphae with cylindrico-clavate terminal elements. All hyphae lack clamp connections.

Habitat: On soil and among decaying leaf litter, solitary or scattered.

Additional collections examined — **INDIA**, **Kerala State, Calicut District,** Puthiyangadi: 29 October 2003, Arun Kumar *AK10;* 14 October 2004, Arun Kumar *AK111a*; **Malappuram District**, Calicut University Campus: 26 October 2004, Arun Kumar *AK153* (*K(M)158616*); 2 November 2004, Arun Kumar *AK153a*; Nilambur: 13 September 2004, Arun Kumar *AK97*; **Wayanad District**, Muthanga: 2 June 2005, Arun Kumar *AK 225*.

Comments: Subglobose to broadly ellipsoid spores that are metachromatic in cresyl blue, obovoid, inflated-clavate, clavate or utriform cheilocystidia, and a pileal covering that is basically a cutis disrupted by ascending patches of loose hyphae with cylindrical, ellipsoid or clavate terminal elements are the distinguishing characters of *L. luteosquamulosus*. Spores that are metachromatic in cresyl blue and the absence of pseudoparaphyses place the species inside *Leucoagaricus*. The combination of characters observed in the present collections does not agree with that of any of the already known lepiotaceous species. Although *Leucoagaricus sericifer* and *L. serenus* are macroscopically similar to *L. luteosquamulosus* (ignoring its smaller basidiomata), micromorphological differences (e.g., spore shape and dimensions, cheilocystidial shape) separate *L. luteosquamulosus* from the other two species. *Leucoagaricus sericifer* is distinguished by a pileal margin lacking sulcate striations, narrower amygdaliform spores, and lageniform cheilocystidia. *Leucoagaricus serenus* has smaller amygdaliform spores and pedicellate-clavate cheilocystidia.

***Leucocoprinus holospilotus*** (Berk. & Broome) D.A. Reid, Mycol. Res. 94: 648 (1990)

Collections examined — **INDIA**, **Kerala State, Malappuram District,** Calicut University Campus: 10 July 2004, Arun Kumar *AK53*; 9 July 2004, Arun Kumar *AK65*; 29 June 2006, Arun Kumar *AK 404* (*K(M)158591*); 30 June 2006, Arun Kumar *AK405*; 10 July 2006, Arun Kumar *AK 416*; 11 July 2006, Arun Kumar *AK404a*; **Calicut District**, Pavangad: 12 June 2005, Arun Kumar *AK257*; Nallalam: 28 June 2006, Arun Kumar *AK402* (*K(M)158590*).

Comments: Except for their slightly larger spore dimensions (7–13 × 5–8 µm), the Kerala collections agree with the description of *Leucocoprinus holospilotus* given by Pegler (1972, 1986, as *Lepiota holospilota*) based on the type materials of two species (Thwaites 1171 and Thwaites 1168, holotypes of *Agaricus holospilotus* and *A. biornatus*, respectively) originally described by Berkeley & Broome (1871) from Sri Lanka. Pegler justified synonymising *A. holospilotus* and *A. biornatus* because, except for the smaller basidiomata of the former, the two are identical in all macroscopic and microscopic characters. After study of

the type materials and the original diagnoses and illustrations of the two species, Reid (1990) accepted Pegler's synonymy but transferred *L. holospilotus* to *Leucocoprinus* with a remark that considerable confusion exists and that a study of more materials from Sri Lanka is required to establish the precise identity of the species. The present collections from Kerala displayed a continuous range of variations in both macroscopic and microscopic characters. In light of these observations, recognition of two species cannot be supported.

This species has earlier been reported from Kerala by Vrinda et al. (2003) as *Leucocoprinus biornatus* with descriptions almost identical with the present collections. A very close *L. caldariorum* D.A. Reid differs in having a well-developed spreading annulus, broadly amygdaliform spores, and hymeniform pileal surface layer topped with clavate to lanceolate elements. *Leucocoprinus meleagris* differs in having a context that reddens on exposure, an indistinct annulus, and cylindrical to clavate pileal covering elements. *Leucocoprinus bresadolae* could be differentiated based on its twisted and ribbon-like elongated pileal elements and by the lack of any differentiated elements on the stipe surface. However, there appears to be an overlap in range of characters among *L. holospilotus*, *L. caldariorum*, *L. meleagris,* and *L. bresadolae;* more morphological and molecular investigations are required for a better understanding of their taxonomic status and relationships.

***Leucocoprinus lacrymans*** T.K.A. Kumar & Manim., Mycotaxon 90 (2): 393 (2004)

Collections examined — **INDIA**, **Kerala State, Calicut District,** Puthiyangadi: 28 August 2003, Arun Kumar *AK1(L);* 9 April 2004, Arun Kumar *AK17(L)*; 11 April 2004, Arun Kumar *AK17a (L)*; 27 April 2004, Arun Kumar *AK18 (L)*; 27 April 2004, Arun Kumar *AK18a (L)*; 28 April 2004, Arun Kumar *AK18b (L)*; 4 May 2004, Arun Kumar *AK18c (L)*; 8 May 2004, Arun Kumar *AK18d (L)*; 14 July 2004, Arun Kumar *AK67(K(M)158592)*; 10 April 2005, Arun Kumar *AK209*; PAVANGAD: 3 November 2004, Arun Kumar *AK169*; **Malappuram District**, Kondotty: 4 November 2004, Arun Kumar *AK170*.

Comments: This species is clearly related to the *Leucocoprinus badhamii* complex comprising species that redden on bruising or become green in ammonia fumes. A comparison of this species with the related taxa in the 'badhamii' complex is given in Kumar & Manimohan (2004). *Leucocoprinus zeylanicus* seems to be another very closely related species with a known distribution in Africa, Sri Lanka (Guzmán & Guzmán-Dávalos 1992), and India (Vrinda et al. 2003). Reports of *Leucocoprinus zeylanicus* from India are based on collections from Kerala State, with descriptions that lack data on reaction with ammonia. A critical comparison of *L. lacrymans* with representative Kerala *L. zeylanicus* collections (TBGT 2069, TBGT 2091, TBGT 2157, TBGT P5345) and also with *L. zeylanicus* descriptions by Pegler (1977, 1986) based on materials collected

from Africa and Sri Lanka confirms a clear distinction between *L. lacrymans* and *L. zelanicus*. The following major differences distinguish *L. zeylanicus*: 1) glabrous stipe; 2) absence of watery exudates on both pileal and stipe surface; 3) smaller spores with a small germ-pore; 4) vesiculose, ovate, clavate, or lanceolate elements of pileal covering, frequently with apical prolongations; and 5) ventricose-fusoid to lageniform elements of stipe covering with a long slender neck.

***Leucocoprinus fragilissimus*** (Berk. & M.A. Curtis) Pat., Essai taxon.: 171 (1900)

Collections examined — **INDIA, Kerala State, Calicut District,** Peruvannamuzhi: 25 May 2004, Arun Kumar *AK35*; 27 May 2004, Arun Kumar *AK35a*; **Wayanad District**, Muthanga: 2 June 2005, Arun Kumar *AK224* (*K(M)158608*) ; 2 June 2005, Arun Kumar *AK240* (*K(M)158607*).

Comments: This remarkable species is readily recognized in the field because of its extremely fragile and short-lived basidiomata. Microscopically *L. fragilissimus* can be easily distinguished by ovoid to broadly ellipsoid spores that are often constricted apically into a short cylindric region terminated by a wide germ-pore plugged with a hyaline exudate-cap.

***Leucocoprinus ianthinus*** (Cooke) Locq., Bull. mens. Soc. linn. Lyon 14: 94 (1945)

Collections examined — **INDIA, Kerala State, Kannur District,** Neeliyarkottam: 16 October 2004, Arun Kumar *AK140*; **Malappuram District,** Calicut University Campus: 20 October 2004, Arun Kumar *AK142 (K(M)158606)*; 10 November 2004, Arun Kumar *AK142a (K(M)158605)*; 16 November 2004, Arun Kumar *AK142b*.

Comments: *Leucocoprinus ianthinus* is easily recognized in the field by its almost fragile basidiomata with a thin, dull white to greyish pileus covered with scattered greyish brown squamules. Its spores are somewhat large and ellipsoid to amygdaliform, cheilocystidia are inflated clavate to ovoid, and pileal covering consists of cylindrical, ellipsoid or clavate elements intermixed with sphaerocysts.

This species is better known under the name *Leucocoprinus lilacinogranulosus* (Henn.) Locq.; the name *L. ianthinus* is used here following Bon (1996) and Vellinga (2001a).

***Leucocoprinus acutoumbonatus*** T.K.A. Kumar & Manim., **sp. nov.** Figure 8
MycoBank MB512341

*Pileus 20–60 mm latus, convexus vel conico-companulatus, albidus, ad discum brunneus, umbonatus, squamulis floccoseis ad discum confertioribus obtectus, ad marginem striatus. Lamellae liberae, albidae, confertae. Stipes 30–55 × 3–5 mm, albidus. Sporae 8–11 × 6–8 µm, ovoideae vel ellipsoideae, poro germinativo instructae. Basidia 21–33 × 10–13.5 µm, clavata, 4-sporigera. Acies lamellarum sterilis. Cheilocystidia 11–70 × 8–18 µm, versiformia. Pleurocystidia nulla. Trama hymenophoralis subregularis, hyalina. Epicutis pilei disrupta, ex hyphis repentibus et hyphis erectis composita. Hyphae omnes defibulatae.*

**Holotype — INDIA, Kerala State, Malappuram District,** Calicut University Campus: 21 July 2004, Arun Kumar AK72 (K[M]158595).

Etymology: *acutoumbonatus* (Latin), with an acute umbo

Basidiomata small to somewhat medium-sized. Pileus 20–60 mm diam., convex to campanulate when very young, becoming convex to broadly convex and finally conico-campanulate, mostly with a prominent conical umbo, the acuteness of which become pronounced with age; surface dull white for the most part, yellowish white (2A2), towards margin, cinnamon brown (6D6) at the umbo, fibrillose to rather tomentose, with scattered cottony-floccose squamules concentrated more towards the disc, distinctly sulcate-striate towards margin; margin initially incurved, becoming straight, entire to finely serrate. Lamellae free, whitish, turning yellowish brown (5D5) with age, close to crowded, up to 10 mm wide, with lamellulae in 1–4 tiers; edge finely fimbriate to denticulate, concolorous with the sides. Stipe 30–55 × 3–5 mm (up to 10 mm at the base), central, terete, expanding towards base, solid when very young, becoming fistulose to hollow with age; surface whitish with a reddish grey (7B2) tinge, finally turning greyish brown (6D3) with age, turning 'titian red' (7D6) on bruising, pruinose to rather velutinous; base arising from whitish mycelium. Annulus superior, membranous, fixed, with dark brown (6E7) squamules on the upper side. Context less than 2 mm thick, whitish. Stipe context changing to 'titian red' (7D6) on exposure. Odour not distinctive. Spore-print white.

Spores 8–11 × 6–8 (10 ± 1.4 × 7 ± 0.65) µm, Q = 1–1.8, Qm = 1.4, ovoid to ellipsoid with a truncated base and a germ-pore up to 1 mm wide plugged by a lens-cap-like exudate, hyaline, with refractive guttules, thick-walled, smooth, dextrinoid, distinctly metachromatic in cresyl blue, cyanophilic in cotton blue. Basidia 21–33 × 10–13.5 µm, clavate, with guttulate contents, bearing 4 sterigmata up to 5 µm long or occasionally 1–2 abnormally elongated sterigmata up to 16 µm long and 3 µm wide. Lamella-edge sterile. Cheilocystidia 11–70 × 8–18 µm, lageniform or utriform, with subcapitate or long and flexuose or moniliform apex, hyaline to pale grey, thin-walled. Pleurocystidia absent. Lamellar trama subregular; hyphae 2–6 µm wide, inflated up to 10 µm, hyaline, thin-walled, inamyloid. Subhymenium cellular. Pseudoparaphyses abundant. Pileal trama interwoven; hyphae 2–20 µm wide, inflated, hyaline, thin- to slightly thick-walled, inamyloid. Pileal covering a loose disrupted cutis forming trichodermial patches of ascending or erect chains of somewhat inflated, cylindric to subglobose elements, 15–70 × 5–20 µm, hyaline and slightly thick-walled. Stipe covering a trichodermium of erect cylindrical, lageniform, flexuose elements, 20–70 × 3–8 µm, slightly thick-walled, hyaline or pale grey, with obtuse or acuminate apices. All hyphae lack clamp connections.

Habitat: On the bark of living trees or on decaying wood, solitary or in caespitose groups.

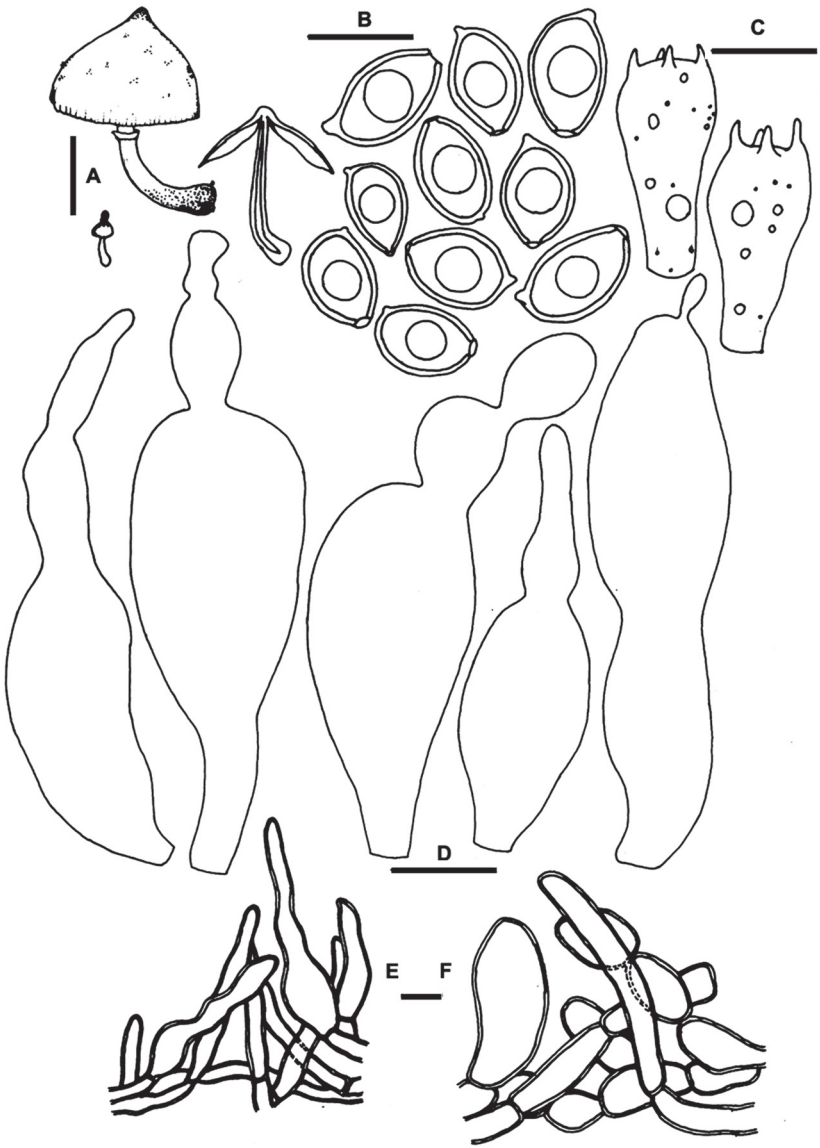


Figure 8. *Leucocoprinus acutoumbonatus*:
A, habit, scale bar = 10 mm; B, basidiospores; C, basidia;
D, cheilocystidia; E, stipe covering; F, pileus covering.
Scale bars (B–F) = 10 μm.

Additional collections examined — **INDIA**, **Kerala State, Malappuram District,** Calicut University Campus: 10 August 2004, Arun Kumar AK72a; 9 August 2004, Arun Kumar AK87 (*K(M)158594*); 10 August 2004, Arun Kumar AK87a; 12 August 2004, Arun Kumar AK87b; 16 August 2004, Arun Kumar AK87c; 20 August 2004, Arun Kumar AK87d; 22 August 2004, Arun Kumar AK72b; 17 July 2006, Arun Kumar AK417.

Comments: *Leucocoprinus acutoumbonatus* is a very distinct species with an acute umbo, whitish pileus with sulcate striations towards the margin, whitish stipe context turning reddish on bruising, membranous annulus with dark brown squamules on the upper side, large ovoid to ellipsoid spores with a conspicuous germ-pore, lageniform or utriform cheilocystidia with moniliform apex, pileal covering entirely made of loosely attached subglobose to cylindric elements and a trichodermial stipitipellis with erect cylindrical, lageniform or flexuose elements. The presence of distinct striations on the pileus and abundant pseudoparaphyses in the hymenium confirms its position within *Leucocoprinus.*

Although *L. acutoumbonatus* exhibits characters that suggest a close relationship with members of the 'badhamii' complex, including a reddish colour change of the stipe context on bruising, species of the complex show a positive ammonia reaction by turning greenish or (exceptionally) pink (as with *L. croceovelutinus* Bon & Boiffard). *Leucocoprinus acutoumbonatus* is unique in its consistently negative ammonia response, even in repeated tests of basidiomata representing different developmental states. While Reid (1990) includes *L. jubilaei* in his key to the 'badhamii complex' species, he noted that the chemical response of *L. jubilaei* was variable; Babos (1979) earlier had noted a positive ammonia reaction for the species. *Leucocoprinus jubilaei*, a small species also encountered in Kerala, was easily distinguished from the *L. acutoumbonatus* collections by highly deviant macroscopic and microscopic characters. The peculiar nature and composition of the pileal covering, along with several other characters distinguishes *L. acutoumbonatus* from other related species.

***Leucocoprinus brebissonii*** (Godey) Locq., Bull. mens. Soc. Linn. Lyon 12: 41 (1943)

Collections examined — **INDIA**, **Kerala State, Malappuram District**, Calicut University Campus: 7 October 2004, Arun Kumar *AK126*; 5 November 2004, Arun Kumar *AK171* (*K(M)158603*); 10 November 2004, Arun Kumar *AK171a*; 10 November 2004, Arun Kumar *AK188* (*K(M)158604*); 3 July 2006, Arun Kumar *AK408*.

Comments: The present collections fit in well with the descriptions of *Leucocoprinus brebissonii* given by Smith (1981), Pegler (1983), Babos (1985), Migliozzi et al. (1989), Vellinga (2001a), and Vrinda et al. (2003). Smith's description seems to be based on larger and more robust basidiomata than those of the present collections. A colour photograph and accompanying

species description by Migliozzi et al. (1989) depict basidiomata with brownish squamules on a pale yellow pileal background whereas Vellinga (2001a) describes squamules that may be dark grey-brown, grey-brown, dark brown to almost blackish on a cream coloured or whitish background. An earlier report on the species from Kerala (Vrinda et al. 2003) records the pileal surface as 'teak brown (6F5), dark brown (7F8) at the disc' and with dark brown squamules on a dull white background. Pileal squamules of the present collections are much lighter and devoid of any grey to blackish squamules. This is a regularly fruiting species in the Malappuram District of Kerala, striking in its sharply contrasting squamules against a whitish background.

***Leucocoprinus venezuelanus*** Dennis, Kew Bull. 15: 109 (1961)

Collections examined — **INDIA**, **Kerala State, Wayanad District,** POOKODE: 26 May 2004, Arun Kumar *AK40* (*K(M)158584*); 27 June 2005, Arun Kumar *AK40a*; **Calicut District**, THAMARASSERY: 26 November 2006, Arun Kumar *AK461* (*K(M)158602*).

Comments: Except for the clavate to inflated-clavate or utriform cheilocystidia, characters of the present collections agree well with the original description of the species from Venezuela (Dennis 1961). The collections also agree with the descriptions provided for materials from the Lesser Antilles (Pegler 1983) and India (Vrinda et al. 2003). *Leucocoprinus venezuelanus* closely resembles *L. brebissonii* with similar basidiomata but differs in having smaller spores. This species is rarely encountered in Kerala, where it has already been reported (Vrinda et al. 2003).

***Leucocoprinus delicatulus*** T.K.A. Kumar & Manim., **sp. nov.** Figure 9

MycoBank MB512342

*Pileus 10–41 mm latus, primo convexus, postea applanato expansus, umbonatus, albidus, squamulis griseis ad discum confertioribus obtectus, ad marginem striatus. Lamellae liberae, albidae, confertae. Stipes 45–60 × 1–2 mm, albidus, vulnerato griseo brunneus. Sporae 9–12 × 6–7 µm, ovo-ellipsoideae vel sub-amygdaliformiae, poro germinativo instructae. Basidia 16–24 × 10–11 µm, clavata, 4-sporigera. Acies lamellarum sterilis. Cheilocystidia 26–66 × 11–21 µm, clavata,versiformia. Pleurocystidia nulla. Trama hymenophoralis subregularis, hyalina. Epicutis pilei disrupta, ex hyphis repentibus et hyphis erectis composita. Hyphae omnes defibulatae.*

Holotype — **INDIA, Kerala State, Malappuram District,** Calicut University Campus: 11 April 2005, Arun Kumar *AK211* (K[M]158582).

Etymology: *delicatulus* (Latin), delicate

Basidiomata small and somewhat fragile. Pileus 10–41 mm diam., convex, becoming broadly convex to applanate, umbonate at the disc; surface whitish with grey (1F1), appressed squamules which are concentrated more towards the disc and sparser towards the margin, pruinose at the disc, distinctly striate towards margin; margin initially incurved, later straight, entire to eroded.

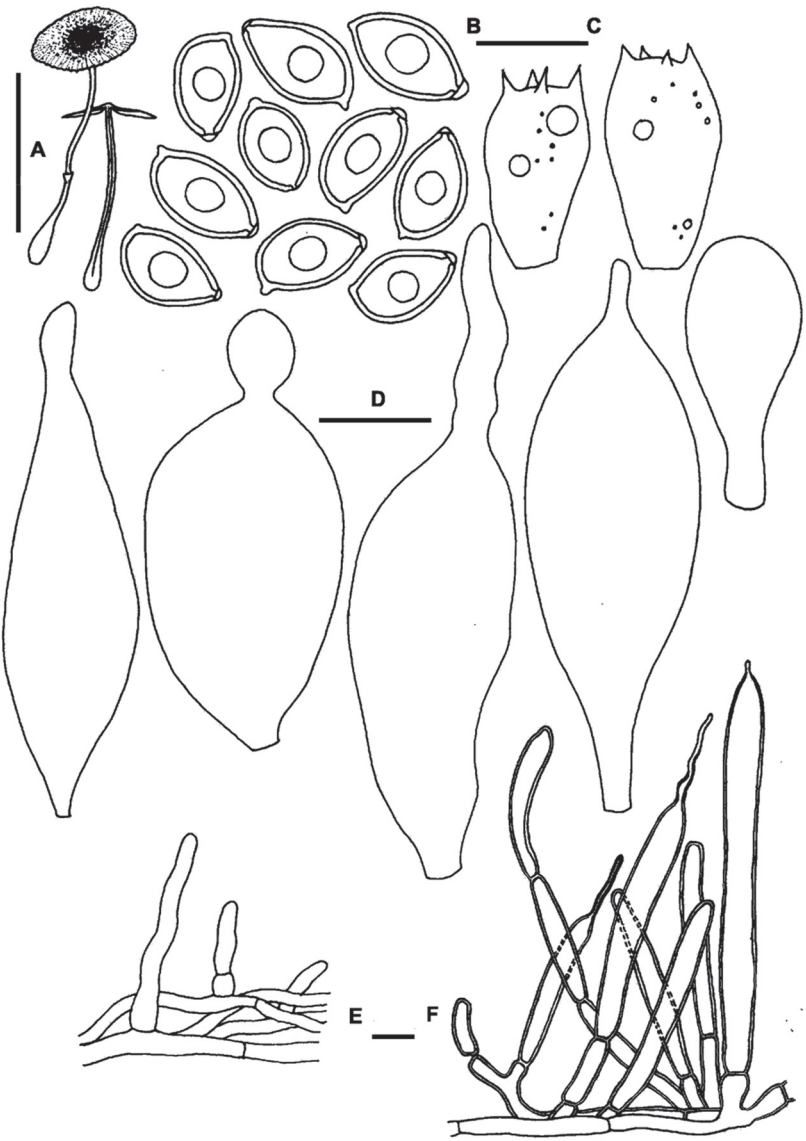


Figure 9. *Leucocoprinus delicatulus*:
A, habit, scale bar = 10 mm; B, basidiospores; C, basidia;
D, cheilocystidia; E, stipe covering; F, pileus covering.
Scale bars (B–F) = 10 μm.

Lamellae free, whitish, crowded, up to 2 mm wide, with lamellulae in 1–2 tiers; edge fimbriate under a lens, concolorous with the sides. Stipe 45–60 × 1–2 mm, (up to 5 mm at the base), central, terete, almost equal with a dilated base, fistulose, becoming hollow; surface whitish, changing to greyish brown (8E3, 9E3) with age or on bruising, fibrillose-villose to rather tomentose; base arising from white mycelium. Annulus inferior, central or superior, membranous, ascending, fixed. Context up to 1 mm thick, whitish. Odour not distinctive. Spore-print white.

Spores 9–12 × 6–7 (10.7 ± 1.09 × 6.8 ± 0.54) µm, Q = 1.4–2, Qm = 1.6, ovo-ellipsoid to subamygdaliform, with a truncate germ-pore covered with a hyaline cap, hyaline, with refractive guttules, thick-walled (up to 2 µm), smooth, dextrinoid, metachromatic in cresyl blue, cyanophilic in cresyl blue. Basidia 16–24 × 10–11 µm, short clavate, hyaline, with guttulate contents, bearing 4 sterigmata up to 4 µm long. Lamella-edge sterile. Cheilocystidia crowded, 26–66 × 11–21 µm, clavate, broadly clavate, lageniform, fusiform or utriform, mostly subcapitate or with flexuose apical prolongations (up to 20 µm long), hyaline, thin-walled. Pleurocystidia absent. Lamellar trama subregular; hyphae 2–6 µm wide, inflated up to 15 µm, branched, hyaline, thin-walled, inamyloid. Subhymenium cellular. Pseudoparaphyses abundant and well developed. Pileal trama interwoven; composed of 5–20 µm wide, hyaline, thin-walled, inflated hyphae, inamyloid. Pileal covering a cutis disrupted by patches of ascending or erect loosely attached terminal elements and entirely trichodermial at the disc; hyphae 3–10 µm wide, thin-walled, hyaline or with grey to dark grey plasmatic and encrusting pigments; terminal elements 28–100 × 4–10 µm, cylindrical with acuminate to obtuse tips or with short or long flexuose apical extensions, thin- to slightly thick-walled. Stipe covering a cutis disrupted by ascending or erect slightly inflated, cylindric to flexuose terminal elements or side branches of repent hyphae; terminal elements, 24–92 × 7–10 µm; hyphae 3–17 µm wide, thin-walled, hyaline or with grey to dark grey plasmatic pigment. All hyphae devoid of clamp connections.

Habitat: On soil, among decaying leaf litter, solitary or scattered.

Additional collections examined — **INDIA**, **Kerala State, Malappuram District,** Calicut University Campus: 12 April 2005, Arun Kumar *AK211a*; 13 April 2005, Arun Kumar *AK213* (*K(M)158583*); 3 June 2005, Arun Kumar *AK231*.

Comments: This fragile coprinoid species is diagnosed by large truncate spores, short basidia, versiform cheilocystidia with apical excrescences, and cylindrical pileal elements mostly with abruptly constricted apices. *Leucocoprinus delicatulus* is greatly resembles *Leucocoprinus ianthinus* (= *L. lilacinogranulosus*) in general appearance. However, microscopically the present collection is distinguished from *L. ianthinus* by the cheilocystidia with apical prolongations

and a trichodermial pileal disc entirely made up of cylindric pileal elements that reach up to 100 µm in length.

***Leucocoprinus pusillus*** T.K.A. Kumar & Manim., **sp. nov.** Figure 10

MycoBank MB512343

*Pileus 13–16 mm latus, primo subglobosus, postea convexus, umbonatus, albidus, squamulis brunneis ad discum confertioribus obtectus, ad marginem striatus. Lamellae liberae, albidae, confertae. Stipes 20–22 × 3–5 mm, albidus, vulnerato brunneus. Sporae 7–10 × 5–6 µm, ovoideae, ovo-ellipsoideae vel ellipsoideae, poro germinativo instructae. Basidia 18–27 × 9–12 µm, clavata, 4-sporigera. Cheilocystidia 26–49 × 7–21 µm, versiformia. Pleurocystidia nulla. Trama hymenophoralis subregularis, hyalina. Epicutis pilei disrupta, ex hyphis repentibus et hyphis erectis composita. Hyphae omnes defibulatae.*

**Holotype — INDIA, Kerala State, Thiruvananthapuram District,** PALODE: 20 July 2005, Arun Kumar AK367 (K[M]158581).

Etymology: *pusillus* (Latin), dwarf

Basidiomata small. Pileus 13–16 mm diam., subglobose to convex, becoming broadly convex, with a rather indistinct umbo; surface white with scattered, minute, dark brown (8F8) to dark grey (8F1), fibrillose squamules that are more concentrated and recurved at the disc, distinctly sulcate-striate towards margin; margin initially incurved, later straight, entire. Lamellae free, whitish, turning yellowish white (3A2) to brown (6E6) with age and on drying, crowded, up to 2 mm wide, with lamellulae in 3–4 tiers; edge finely fimbriate under a lens, concolorous with the sides. Stipe 20–22 × 3–5 mm, central, terete, expanding towards base, fistulose; surface whitish, turning brown (6E5, 6E6) on bruising, fibrillose; base arising from a whitish mycelium. Annulus superior, membranous, ascending, with a rim covered with dark brown (8F8) fibrillose scales. Context up to 1 mm thick, whitish, turning brown (6E6) on exposure. Odour not distinctive. Spore-print not obtained.

Spores 7–10 (11) × 5–6 (7) (8 ± 1 × 5.9 ± 0.54) µm, Q = 1.2–1.6, Qm = 1.4, ovoid, ovo-ellipsoid, or ellipsoid, with a rather inconspicuous germ-pore (up to 1 µm in some), hyaline, with refractive guttules, thick-walled (up to 1.5 µm), smooth, dextrinoid, metachromatic in cresyl blue, cyanophilic in cotton blue. Basidia 18–27 × 9–12 µm, clavate, hyaline, with guttulate contents, bearing 4 sterigmata up to 3 µm long. Cheilocystidia crowded, 26–49 × 7–19 µm, cylindrico-clavate, clavate, inflated clavate, or utriform, many with a slightly mucronate apex (up to 3 µm long), hyaline, thin-walled. Pleurocystidia absent. Lamellar trama subregular; hyphae 2–5 µm wide, inflated up to 16 µm, hyaline, thin-walled, inamyloid. Subhymenium cellular. Pseudoparaphyses well developed. Pileal trama interwoven; hyphae 3–17 µm wide, hyaline, thin- to slightly thick-walled, slightly inflated, inamyloid. Pileal covering a cutis composed of filamentous, 2–15 µm wide, slightly agglutinated, hyaline to pale greyish, thick-walled (up to 1 µm) hyphae, which becomes highly

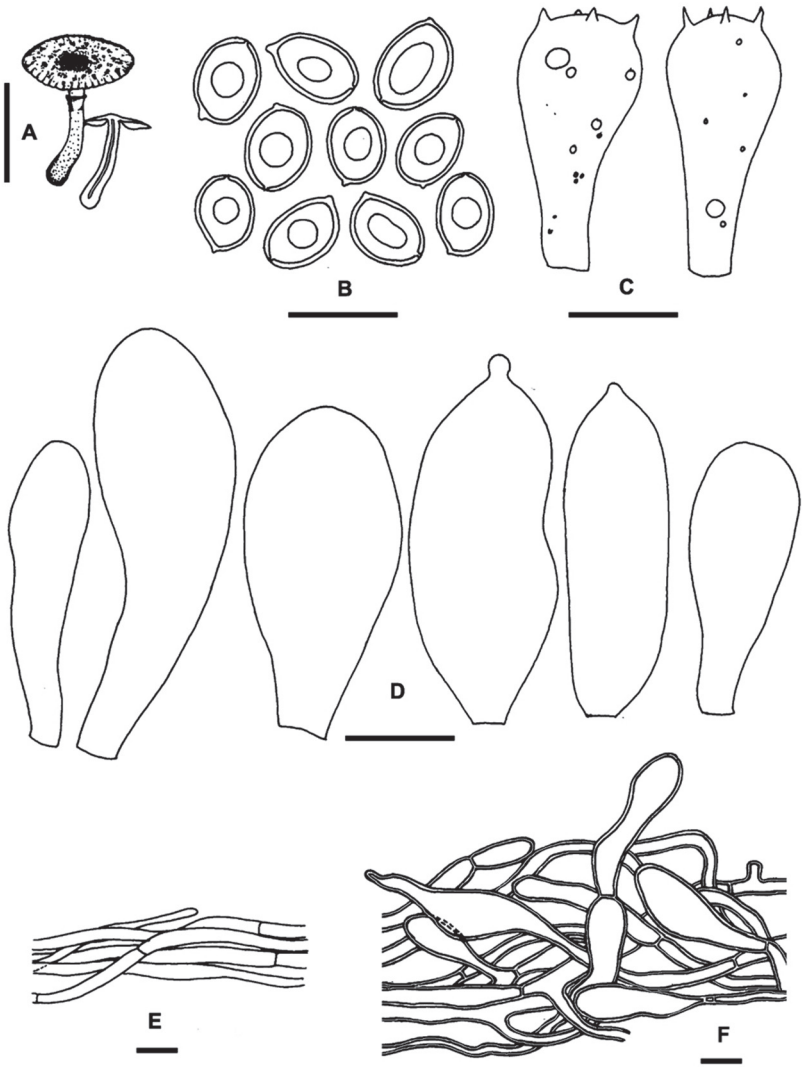


Figure 10. *Leucocoprinus pusillus*:
A, habit, scale bar = 10 mm; B, basidiospores; C, basidia;
D, cheilocystidia; E, stipe covering; F, pileus covering.
Scale bars (B–F) = 10 μm.

disrupted and irregular at the disc and at the scales, with ascending or erect terminal elements; terminal elements 17–69 × 5–17 µm, mostly clavate or lageniform, rarely cylindrico-clavate, or utriform, thick-walled (up to 1 µm), with dark greyish brown plasmatic, membrane-, and encrusting pigments. Stipe covering a cutis of 2–12 µm wide, thin-walled, hyaline or pale yellow to brownish, slightly agglutinated hyphae with cylindrical end-cells. Clamp connections absent.

Habitat: On organic manure rich soil, solitary.

Additional collections examined — **INDIA, Kerala State, Thiruvananthapuram District,** PALODE: 20 July 2005, Arun Kumar *TBGT 9140*.

Comments: *Leucocoprinus pusillus* is a striking species with ellipsoid to ovo-ellipsoid spores with an inconspicuous germ-pore, cheilocystidia rarely with a mucronate apex, and thick-walled pileal elements with plasmatic, membrane-, and encrusting pigments. This character combination indicates affiliation with the '*Leucocoprinus badhamii* complex' characterized by Reid (1990) for species with a rubescent flesh that becomes green in ammonia fumes. A colour reaction on exposure to ammonia was found to be absent in the present species, although the context turned brown (6E5, 6E6) on bruising. Within the 'badhamii complex,' *Leucocoprinus croceovelutinus* does not turn green on exposure to ammonia. Although Babos (1979) reports this as a negative reaction, *L. croceovelutinus* exceptionally reacts positively by turning pink on exposure to ammonia fumes. That species, however, is of moderate size (pileus 30–40 mm diam.) with a non-striate pileal margin. It reddens on bruising and has spores with a distinct papillate apex without a germ-pore and cheilocystidia with prominent apical prolongation. The negative reaction with ammonia and the characteristically small size of basidiomata of the present collections keeps it distinct from all other members of the group. *Leucocoprinus jubilaei*, also with a negative colour reaction with ammonia, differs primarily by the basidiome size and spore characteristics.

***Leucocoprinus munnarensis*** T.K.A. Kumar & Manim., **sp. nov.** Figure 11
MycoBank MB512344

*Pileus 27–51 mm latus, primo convexus, postea applanato expansus, umbonatus, albidus, squamulis granulareis griseis ad discum confertioribus obtectus, ad marginem striatus. Lamellae liberae, albidae, confertae. Stipes 50–80 × 3–5 mm, albidus, vulnerato brunneus. Sporae 8.5–12.5 × 6–8 µm, amygdaliformiae, poro germinativo instructae. Basidia 19–22 × 10–11 µm, clavata, 4-sporigera. Cheilocystidia 20–39 × 7–21 µm, versiformia. Pleurocystidia nulla. Trama hymenophoralis subregularis, hyalina. Epicutis pilei disrupta, ex hyphis repentibus et hyphis erectis composita. Hyphae omnes defibulatae.*

Holotype — **INDIA, Kerala State, Idukki District,** MADUPETTY: 10 June 2006, Arun Kumar AK393 (K[M]158580).

Etymology: *munnarensis* (Latin), pertaining to the type locality, Munnar.

Basidiomata small to somewhat medium-sized. Pileus 27–51 mm diam., initially convex, becoming broadly convex to applanate, umbonate at the disc; surface whitish with scattered, minute, dark grey (1F1) to blackish, squamules that are almost granular and more concentrated towards the centre and sparser towards the margin, distinctly striate towards margin; margin initially incurved, later straight, entire or slightly eroded in some specimen. Lamellae free, whitish, crowded, up to 2.5 mm wide, with lamellulae in 2–5 tiers; edge fimbriate under a lens, concolorous with the sides. Stipe 50–80 × 3–5 mm, (up to 5 mm at the base), central, terete, almost equal, slightly expanding towards base, fistulose, finally becoming hollow; surface whitish, turning brown (6E5, 6E6) on touch, on bruising or when cut, fibrillose; base arising from whitish mycelium. Annulus superior, membranous, movable, evanescent. Context up to 1 mm thick, whitish, gradually turning brown (6E5) on exposure. Odour not distinctive. Spore-print not obtained.

Spores 8.5–12.5 × 6–8 (10.4 ± 1.04 × 7 ± 0.54) µm, Q = 1.3–1.7, Qm = 1.5, amygdaliform, with a germ-pore covered by a hyaline pore-cap, hyaline, with refractive guttules, thick-walled (up to 1 µm), smooth, dextrinoid, distinctly metachromatic in cresyl blue, cyanophilous in cotton blue. Basidia 19–22 × 10–11 µm, clavate, hyaline, with guttulate contents, bearing 2–4 sterigmata up to 7 µm long. Cheilocystidia crowded, 41–66 × 10–25 µm, clavate, versiform: inflated clavate, narrowly lageniform, or utriform, mostly with cylindrical or flexuose apical prolongations up to 27 µm long, hyaline, thin-walled. Pleurocystidia absent. Lamellar trama subregular; hyphae 3–15 µm wide, inflated up to 30 µm, hyaline, thin-walled, inamyloid. Subhymenium cellular. Pseudoparaphyses well developed and prominent. Pileal trama interwoven; composed of 5–25 µm wide, hyaline, thin-walled, inflated, inamyloid hyphae. Pileal covering a disrupted cutis composed of 3–25 µm wide, slightly inflated, thin- to slightly thick-walled, grey to dark grey pigmented hyphae, with ascending or erect trichodermial patches of fusoid or cylindrical, thin- to slightly thick-walled terminal elements, 43–190 × 4–10 µm, with obtuse tips. Stipe covering a cutis of 4–11 µm wide, thin-walled, hyaline hyphae, disrupted by bundles of ascending or erect terminal elements; terminal elements; 30–57 × 3–7 µm, cylindrical, with hyaline to pale grey plasmatic pigment. All hyphae lack clamp connections.

Habitat: On soil, solitary or scattered.

Comments: The distinctive characters of *Leucocoprinus munnarensis* are basidiomata that bruise brown but do not change colour with ammonia, large spores with a broad germ-pore covered by a hyaline cap, cheilocystidia with mucronate apex, and a trichodermial pileal disc made up entirely of fusoid or cylindric terminal elements that may reach up to 190 µm in length. *Leucocoprinus brebissonii*, earlier reported from Kerala (Vrinda et al. 2003),

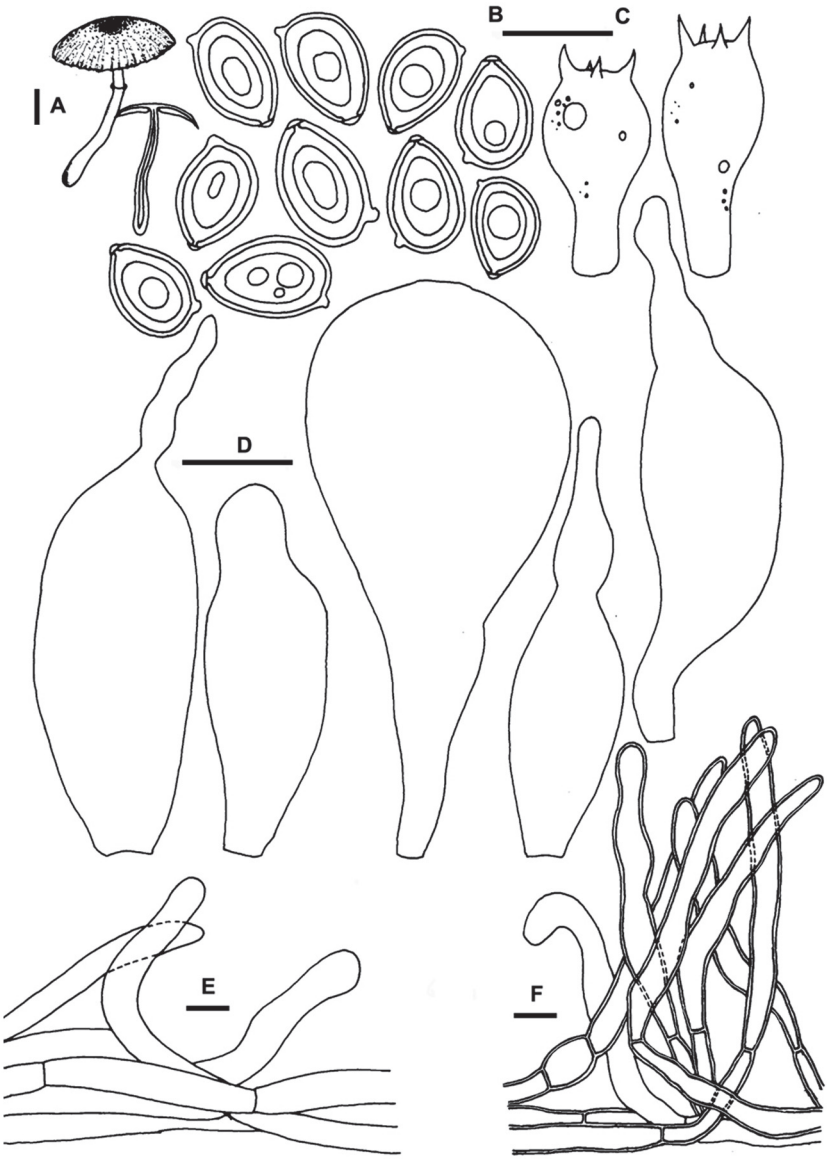


Figure 11. *Leucocoprinus munnarensis*:
A, habit, scale bar = 10 mm; B, basidiospores; C, basidia;
D, cheilocystidia; E, stipe covering; F, pileus covering.
Scale bars (B–F) = 10 μm.

seems very close, but *L. munnarensis* does not agree with descriptions of *L. brebissonii* (Candusso & Lanzoni 1990, Bon 1996, Vellinga 2001a, Vrinda et al. 2003) due to its basidiomata bruising brownish and the absence of the terminal pileal covering cells that are 'cylindrical and short to ellipsoid-clavate to globose elements, in chains or disorderly arrangements' that characterize *L. brebissonii* (Vellinga 2001a). Vrinda et al. (2003) described the covering at the pileal disc of *L. brebissonii* as 'hymeniform' with 'clavate to ovoid, detersile elements.' A comparison with the colour photograph of *L. brebissonii* in Migliozzi et al. (1989: 27) also supports separation of the two species.

***Leucocoprinus cretaceus*** (Bull.) Locq., Bull. mens. Soc. Linn. Lyon 14: 93 (1945)

Collections examined — **INDIA**, **Kerala State, Malappuram District,** Calicut University Campus: 8 October 2003, Arun Kumar *AK3*; 4 May 2004, Arun Kumar *AK19*; 5 May 2004, Arun Kumar *AK21* (*K(M)158576*); 6 May 2004, Arun Kumar *AK21a*; 29 June 2004, Arun Kumar *AK60*; 19 July 2004, Arun Kumar *AK69*; 8 July 2006, Arun Kumar *AK437* (*K(M)158575*).

Comments: Characters of the Kerala collections agree with those of the species from Sri Lanka as given by Pegler (1986) under the name *Leucocoprinus cepistipes*. However, *L. cepistipes* seems to have been misapplied to the taxon currently recognized as *L. cretaceus* (see Vellinga 2001a). *Leucocoprinus cretaceus* is characterized by somewhat large basidiomata with chalk-white, cottony or plush-like, detersile squamules on the pileus and stipe, spores often with a conspicuous hyaline cap over the germ-pore, and cylindrical or slightly branched pileal covering elements. Remarkably, our collections from Kerala agree well with Vellinga's (2001a) description of *L. cretaceus*, and therefore our collections are treated here under that epithet. *Leucocoprinus cepistipes* in the present sense has a pileus with brownish centre and uplifted brownish squamules, stipe with a densely and finely pubescent surface, spores with germ-pore lacking a distinct hyaline cap, and cylindrical to narrowly lageniform terminal elements on the pileus and stipe covering.

***Leucocoprinus birnbaumii*** (Corda) Singer, Sydowia 15: 67 (1962) ["1961"]

Collections examined — **INDIA**, **Kerala State, Calicut District,** Puthiyangadi: 25 July 2004, Arun Kumar *AK82* (*K(M)158574*); 1 September 2004, Arun Kumar *AK82a*; **Wayanad District**, KALPETTA: 26 May 2004, Arun Kumar *AK39*; **Malappuram District**, Calicut University Campus: 2 June 2004, Arun Kumar *AK42*.

Comments: This species, easily identified by its yellowish basidiomata, ovoid to ellipsoid spores with a germ-pore, and cylindrical pileal surface elements, is one of the most widely known and studied lepiotaceous fungi. Although cosmopolitan in distribution, *L. birnbaumii* is encountered in the temperate regions in green houses and botanic gardens maintaining tropical plants. This species has already been reported from Kerala by Vrinda et al. (2003).

***Leucocoprinus jubilaei*** (Joss.) Wasser, Novit. Syst. Plant. non Vasc. 2: 191 (1976)

Collections examined — **INDIA**, **Kerala State, Malappuram District**, Calicut University Campus: 15 October 2004, Arun Kumar *AK137* (*K(M)158572*); 26 October 2004, Arun Kumar *AK148*; 26 October 2004 Arun Kumar *AK149*; 1 November 2004, Arun Kumar *AK148a*; 2 November 2004, Arun Kumar *AK163* (*K(M)158573*); 5 November 2004, Arun Kumar *AK172*; 9 November 2004, Arun Kumar *AK172a*; 10 November 2004, Arun Kumar *AK172b*; 16 November 2004, Arun Kumar *AK202*; **Thiruvananthapuram District**, PALODE: 18 July 2005, Arun Kumar *AK368*; 20 July 2005, Arun Kumar *AK371*; 3 August 2006, Arun Kumar *AK424*; 4 August 2006, Arun Kumar *AK427*.

Comments: As already noted, *L. jubilaei* belongs to the 'badhamii complex'. The present collections differ from the species as described by Babos (1979) in showing a negative ammonia reactivity and absence of coloured pigments in cheilocystidia. It differs from the account given by Reid (1990) in smaller basidiome size and cheilocystidial morphology. In his comprehensive discussion on the species, Reid (1990) notes, "Ammonia gives a variable reaction from intense green to a rather feeble grey-green to absolutely no reaction," which supports the negative chemical response of the Kerala collections. Hungarian specimens studied by Babos (1979) often possessed cheilocystidia with versiform appendages that were up to 54 µm long although she did note the lack of apical appendages in Josserand's material and original descriptions, suggesting that basidiome developmental stage might explain the presence/absence of such outgrowths. Except for these deviating characters, the present collections are in close agreement with *L. jubilaei*. This is a rather common *Leucocoprinus* species found throughout Kerala.

***Leucocoprinus submontagnei*** Heinem., Bull. Jard. Bot. Nation. Belg. 47: 84 (1977)

Collections examined — **INDIA**, **Kerala State, Calicut District,** Puthiyangadi: 29 October 2003, Arun Kumar *AK9*; 12 November 2003, Arun Kumar *AK9a*; 9 May 2004, Arun Kumar *AK23* (*K(M)158600*); 19 May 2004, Arun Kumar *AK23a*; 21 May 2004, Arun Kumar *AK23b*; **Malappuram District**, Calicut University Campus: 24 May 2004, Arun Kumar *AK31*; 24 May 2004, Arun Kumar *AK32*; 3 June 2004, Arun Kumar *AK43*; 9 November 2004, Arun Kumar *AK179* (*K(M)158599*); 10 November 2004, Arun Kumar *AK179a*; 10 November 2004, Arun Kumar *AK189*; 28 June 2005, Arun Kumar *AK320*.

Comments: *Leucocoprinus submontagnei* is a widespread species in Kerala. It is a fragile species characterized by a whitish to yellowish white pileus that is distinctly sulcate-striate towards the margin; ovoid, ellipsoid or broadly ellipsoid spores with an indistinct germ-pore; and a pileal covering with cylindric elements projecting from chains of more or less ovoid to ellipsoid cells. Except for their slightly larger spores, the present collections agree with the diagnostic characters of the African species (Heinemann 1977, Pegler 1977). *Leucocoprinus lanzonii* Bon et al. closely resembles *L. submontagnei* in general appearance and

in most microscopic features but differs in having slightly larger basidiomata and smaller spores. Other related species like *L. medioflavus* (Boud.) Bon and *L. denudatus* (Rabenh.) Singer could also be distinguished based chiefly on basidiome size and smaller spores. Although it has subglobose spores lacking a germ-pore, *Leucocoprinus denudatus* differs in the arrangement and shapes of its pileal elements. *Leucocoprinus truncatus* (A. Pearson) D.A. Reid & Eicker (Reid & Eicker 1993), which resembles *L. submontagnei* in general appearance and has an almost identical cuticular structure, can be separated by its thick annulus with brownish rim and larger amygdaliform spores with apical germ-pore.

***Leucocoprinus straminellus*** (Bagl.) Narducci & Caroti, Memorie Soc. Tosc. Sci. Nat., Ser. B 102: 49 (1996) ["1995"]

Collection examined — **INDIA, Kerala State, Calicut District,** PERUVANNAMUZHI: 25 May 2004, Arun Kumar *AK34* (*K(M)158571).*

Comments: This species has granular squamules scattered on a whitish to yellowish white pileal background, distinct striations towards the margin, and a pileal covering with epithelial patches of sphaerocysts. Characters of the present collection agree with the description of *L. straminellus* by Vellinga (2001a) except for the dark brown coloured squamules, smaller spores (5–6.5 × 3.5–4.5 µm), and absence of lageniform cheilocystidia. No annulus was seen in the Kerala collection.

The well-known *L. denudatus* is now considered a synonym of *L. straminellus* (Vellinga 2001a). Comparison with the Migliozzi et al. (1989) colour photograph of *L. denudatus* indicates an overall macroscopic similarity except for the more yellowish pileus with concolorous squamules. Despite the colour variation, the microscopical similarities are evident from the accompanying description.

*Leucocoprinus cygneus* (J.E. Lange) Bon is a related species with white lamellae, amygdaliform spores, larger cheilocystidia that are mostly lageniform and reaching up to 100 µm long, and pileal elements with encrusting pigments. *Leucocoprinus submontagnei* Heinem. has white lamellae and much larger spores ((5.4–)6.5–8.1(–9.0) × 4.2–5.1, from the original account by Heinemann 1977). *Lepiota micropholis* (Berk. & Broome) Sacc. with a plicate-striate pileus differs chiefly in having larger basidiomata, persistent annulus, and in missing sphaerocysts in the pileal covering.

### Taxonomic observations

As already noted, Singer (1986) considered the presence of pseudoparaphyses as an important marker to recognize *Leucocoprinus* species although a preliminary molecular study (Vellinga 2004b) does not support this view. Our recent observations of numerous fresh and dried representatives of *Leucocoprinus*

species suggest that the presence of pseudoparaphyses is indeed a strong diagnostic character for a morphological-based concept of *Leucocoprinus*. Determining hymenial pseudoparaphyses based solely on shape was often difficult; we stained a lamellar cross-section with a mixture of 1% aqueous phloxine and Congo red solutions for 10 minutes and then washed with 3% aqueous KOH to remove excess stain, which exposed notable difference between the degree of stain retained by the pseudoparaphyses and other hymenial cells. Basidia stained bright pinkish orange to red, indicating a high affinity for both Congo red and phloxine, while the pseudoparaphyses stained much lighter. The cell walls of the pseudoparaphyses stained with the wall-specific Congo red; the lack of phloxine stain indicated an absence or shortage of cytoplasm. We found it easy to distinguish between *Leucoagaricu*s and *Leucocoprinus* by using this differential staining technique to check for pseudoparaphyses.

Another interesting observation is that clamp connections appear completely absent only in *Leucocoprinus* species and are observed, although rarely, in many *Leucoagaricus* species collected from Kerala. Clamp connections have been observed in some other *Leucoagaricus* species (see discussion under *L. majusculus*) as well (Wasser 1993). This contradicts the original taxonomic concepts where both genera were regarded as generally clampless. Based on our observations, we feel that 'absence of clamp connections' as a distinguishing character should be restricted to *Leucocoprinus* species. The absence of clamp connections in species belonging to the "badhamii complex" substantiates our consideration of those species under *Leucocoprinus*.

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